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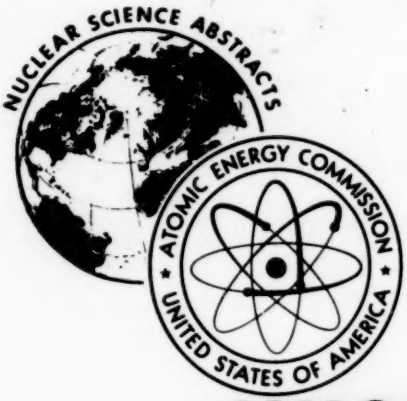


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Volume 19, Number 17, September 15, 1965

# NUCLEAR SCIENCE ABSTRACTS

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Volume 19, Number 17 September 15, 1965

# NUCLEAR SCIENCE ABSTRACTS

# BIOLOGY AND MEDICINE

## General

*Refer also to abstracts 32053, 32060, 32254, 32260, and 32595.*

**31659** (ACRH-23) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Jacobson, Leon O. (ed.) (Argonne Cancer Research Hospital, Chicago, Ill.). Mar. 1965. Contract AT(11-1)-69. 178p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Separate abstracts were prepared for thirteen sections of this report. Three sections were abstracted previously and appeared in NSA Vol. 19 as numbers 8863, 17470, and 14140. A list is included of thirty-seven publications during the period covered by this report. (C.H.)

*For abstracts of individual sections see: 31660, 31661, 31662, 31663, 31664, 31665, 31666, 31667, 31668, 31669, 31699, 31700, 31759, 31760, 31761, 31762, 31763, 31764, 31765, 31766, 31767, 31768, 31769, 31770, 31771, 31772, 31773, 31774, 31775, 31776, 31777, 31890, 31891, 31929, 32040, 32041, 32042, 32043, 32044, 32093, 32240, and 32241.*

**31660** (ACRH-23(p.40-57)) IMPAIRED DELAYED RESPONSE FROM THALAMIC LESIONS IN MONKEYS. Schulman, S. (Argonne Cancer Research Hospital, Chicago, Ill.).

The relevance of the thalamus to intelligent behavior, which is suggested by its cortical connections, and by a few instances of selective thalamic disease in man, has been difficult to verify experimentally. Results are reported from experiments undertaken to determine whether the lack of effect of dorsomedial lesions in monkeys (Macaca mulatta) on delayed response may be a consequence of preservation of portions of the nucleus. The lesions were made by implanting $^{90}Y$ sources in the thalamus. The animals were trained in a conditional visual discrimination problem, in addition to delayed response, in order to assess the degree of specificity which might attach to any defects produced in delayed response. Neurological examinations were carried out routinely preoperatively and 1 week following each operation, and several times thereafter. Eye movements, pupillary reactions to light and on convergence, muscle tone, deep reflexes, pain reactions to an alligator clip, and recognition of edible objects placed in the hands outside the field of vision were examined with the animals restrained in a primate chair. Visual fields were examined by bringing food into the periphery of the fields with the monkey's gaze fixed on another piece of food held directly in front of his face, and also by giving the animal access to a row of banana sections on a table surface extending into the periphery of the right and left fields. Taste sensation was examined by presenting sections of banana soaked in a saturated solution of quinine hydrochloride. Behavior tests were carried out in animals given pre- and postoperative training in spatial delayed response and in a conditional visual discrimination problem. Since the goal of total destruction of the dorsomedial nuclei was accomplished in only 3 animals, the conclusions suggested by the observations are proposed provisionally. They are that the dorsomedial nucleus in monkeys is an essential component of the mechanism by which novel and transient events are represented and held centrally for relatively brief periods of time. There appears to be little or no regional localization within the nucleus in respect to this function. Instead, a high degree of equipotentiality is exhibited, and a remarkably small portion of the nucleus may be sufficient for normal performance. Although in some animals incomplete lesions may produce deficits in delayed response, these are usually quite mild. What determines this individual variation in susceptibility to sub-total lesions is not clear. (C.H.)

**31661** (ACRH-23(p.62-9)) DEFICIENT CHOLESTEROL ESTERIFYING ABILITY OF LESION-FREE SKIN SURFACES IN PSORIATIC INDIVIDUALS. Gara, A.; Estrada, E.; Rothman, S.; Lorincz, A. L. (Argonne Research Hospital, Chicago, Ill.).

Many lines of evidence support the view that keratinization and cholesterol metabolism in the epidermis are intimately connected. Results are reported for studies undertaken to demonstrate directly cholesterol esterifying activity on the skin surface, and to compare this activity in normal and non-involved psoriatic skin. (C.H.)

**31662** (ACRH-23(p.87-98)) BIOLOGIC PROPERTIES OF POLYNUCLEOTIDES. V. STUDIES ON THE INHIBITION OF THE FIRST COMPONENT OF COMPLEMENT BY POLYINOSINIC ACID; THE INTERACTION WITH C'1q. Yachnin, S.; Rosenblum, D.; Chatman, D. (Argonne Cancer Research Hospital, Chicago, Ill.).

Recent reports revealed that the synthetic polynucleotide of inosinic acid, poly I, is an inhibitor of the first component of C' (C'1), but has no effect upon C'1 esterase activity. This phenomenon led to the speculation that poly I might inhibit C'1 by interacting with it at a molecular site which did not affect esterase activity per se, but rather some other functional portion of the molecule. Subsequent studies described the resolution of C'1 activity into three separate protein components, C'1q, C'1r, and C'1s, all three of which were necessary for C'1 activity. C'1q was shown to be identical with the 11S component; C'1s was identified as C'1 proesterase; C'1r was a component of C'1 never before described. It was further shown that these subcomponents comprise a macromolecular complex which is responsible for hemolytic C'1 activity. Experiments were designed to see whether poly I could be shown to interact specifically with one or more of the subcomponents of C'1. Results demonstrate that poly I is a specific inhibitor of the C'1q portion of the C'1 macromolecule. In addition, the inhibition of C'1 hemolytic activity was studied in greater detail than was previously possible. The ability of other synthetic ribopolynucleotides to inhibit human C'1 activity was assessed by the method

used for poly I. Their relative potency was found to be similar to that previously noted for whole C′ inhibition. The following abbreviations are used: poly I, poly A, poly G, poly C, poly U; the synthetic homoribopolynucleotides of inosinic, adenylic, guanylic, cytidylic, and uridylic acids respectively: poly GU; a mixed copolymer of guanylic and uridylic acids: poly IU; a mixed copolymer of inosinic and uridylic acids. (C.H.)

**31663** (ACRH-23(p.99-109)) BIOLOGIC PROPERTIES OF POLYNUCLEOTIDES. VI. FURTHER STUDIES ON THE MECHANISM OF COMPLEMENT INHIBITION BY POLYINOSINIC ACID: THE INACTIVATION OF THE FOURTH COMPONENT OF COMPLEMENT. Yachnin, S.; Rosenblum, D.; Chatman, D. (Argonne Cancer Research Hospital, Chicago, Ill.).

Results are reported from studies of the mechanism of complement inhibition by polyinosinic acid in which synthetic homoribopolynucleotides were used. (C.H.)

**31664** (ACRH-23(p.110-17)) BIOLOGIC PROPERTIES OF POLYNUCLEOTIDES. VII. VASCULAR PERMEABILITY IN GUINEA PIG SKIN INDUCED BY POLYINOSINIC ACID. Yachnin, S.; Ruthenberg, J. M. (Argonne Cancer Research Hospital, Chicago, Ill.).

Vascular permeability of guinea pig skin was induced by synthetic polyinosinic acid. The fact that this material was capable of interacting with the complement system suggests a relationship between the two phenomena. (C.H.)

**31665** (ACRH-23(p.118-32)) ENZYMATIC SYNTHESIS OF RIBONUCLEIC ACID. IV. THE DEOXYRIBONUCLEIC ACID-DIRECTED SYNTHESIS OF COMPLEMENTARY CYTOPLASMIC RIBONUCLEIC ACID COMPONENTS. Robinson, W. S.; Hsu, W-T.; Fox, C. F.; Weiss, S. B. (Argonne Cancer Research Hospital, Chicago, Ill.).

The ribonucleic acid product formed by ribonucleic acid polymerase resembles its deoxyribonucleic acid template in base composition and in base sequence. The reaction in vitro results in the synthesis of RNA chains which are complementary to both DNA strands. Evidence for this originates from the formation of highly ordered RNA structures when the RNA polymerase product is annealed with itself, and from base composition analysis of the polymerase product when primed by single or double stranded ΦX174 DNA. Self-annealed synthetic complementary ribonucleic acid exhibits properties very similar to helical DNA. Although RNA polymerase catalyzes the synthesis of two complementary ribopolymers in vitro, studies with bacteriophage systems have led to the conclusion that informational RNA results from the transcription of only one DNA strand in vivo. It is not yet certain whether the bacteriophage systems represent a general transcription mechanism or a specialized case. Observations by other investigators have led to the belief that the synthesis of most, if not all, cytoplasmic RNA is under the direction of DNA. Enucleated cells show a rapid drop in the content of their cellular RNA. Actinomycin D, an inhibitor of RNA polymerase, prevents the synthesis of cytoplasmic RNA when given to whole cells. Other evidence in support of this concept is the demonstration of specific RNA-DNA hybrid formation between microbial cytoplasmic ribonucleic acids and homologous DNA. Hybrid formation of this type implies the presence of nucleotide sequences in cytoplasmic RNA which are complementary to base sequences in DNA. Therefore, DNA directs not only the synthesis of template RNA for protein synthesis, but ribosomal and transfer ribonucleic acids as well. The high degree of self-complementarity among the RNA chains formed by RNA polymerase suggested the possiblity that the self-complementary ribonucleic acid product might contain one strand which was identical in base sequence with ribosomal and transfer RNA, and the other strand complementary to these cytoplasmic ribopolymers. A demonstration of synthetic ribonucleic acid complementary to natural cytoplasmic ribonucleic acids would be evidence that the assembly of polyribonucleotides in vitro results in the synthesis of specific nucleic acid chains, and would strengthen conclusions concerning the origin of cytoplasmic RNA. Results are reported from tracer experiments which suggest that part of the RNA synthesized on a DNA template, in vitro, is complementary to homologous 23 S and 16 S ribosomal RNA, and to homologous transfer RNA. Ribonucleic acid labeled with $^{32}P$, RNA polymerase from Micrococcus lysodeikticus, mammalian, viral, and bacterial DNA and RNA preparations, and synthetic RNA were used. (C.H.)

**31666** (ACRH-23(p.133-42)) THE INFLUENCE OF POLYCYCLIC AROMATIC HYDROCARBONS ON BACTERIOPHAGE DEVELOPMENT. Hsu, W-T.; Moohr, J. W.; Weiss, S. B. (Argonne Cancer Research Hospital, Chicago, Ill.).

Results are reported from studies that indicate the selective inhibition of both RNA and DNA bacteriophage multiplication in Escherichia coli spheroplasts by carcinogenic polycyclic hydrocarbons. The mechanism of viral growth inhibition by hydrocarbons was not established. (C.H.)

**31667** (ACRH-23(p.143-57)) STEROID FEVER AND INFLAMMATION. STUDIES WITH 11-KETOPREGNENOLONE IN MAN. Glickman, P. B.; Palmer, R. H.; Kappas, A. (Argonne Cancer Research Hospital, Chicago, Ill.).

A number of 5β-H steroids derived from the endogenous metabolic transformations of cholesterol and gonadal and adrenocortical hormones have been shown to evoke intense pyrogenic reactions when injected into humans. Certain other aspects of steroid pyrogen action were studied, utilizing 11-ketopregnenolone as a chemical prototype of this class of fever-producing agents. This C21 5β-H steroid was selected for use in this study because of its potency, its physiologic origin, and its ready availability in large amounts and in pure form through chemical synthesis. The characteristics of the thermogenic and inflammatory responses induced by this compound may, on the basis of extensive comparisons made with structurally related steroids, be considered to typify those induced generally by appropriate administration of neutral steroid pyrogens to man. Data are reported from studies of the pyrogenic response, leukocyte response, inflammatory response, plasma transfer, and metabolism of 11-ketopregnenolone in man after single or multiple intravenous or oral doses. Inflammatory changes at the sites of steroid injection were studied in biopsies made at various time intervals. The possibility that the centrally acting thermogenic stimulus represents a specific product of steroid induced inflammation regularly formed at the site of injection, i.e., one derived from leukocytes, or formed through other specific steroid-tissue interactions at inflammatory sites, was examined within the limits possible in humans. Failure, in the plasma transfer experiments to demonstrate such a substance does not preclude its formation during the course of steroid fever; it does however make it reasonable to focus attention at present on the possibility that injected steroid itself, or a derivative, plays an active role in the production of fever. This role could involve direct effects on central structures controlling both heat production and heat loss mechanisms in man; or effects on the latter processes alone with transient suppression of sudometer and vasomotor heat dissipation providing the essential background against which any of a variety of stimuli for heat production would lead to fever. A biological action of this type for certain steroids would represent a pharmacological counterpart of the antipyretic activity of cortisol and the lesser though significant temperature lowering actions of natural estrogens and would be consistent with both the well known central nervous system actions of steroids in general and with other recognized drug effects on thermoregulatory structures. A mechanism of fever production considered along these lines would provide a reasonable basis for considering the manner in which steroids such as progesterone and etiocholanolone participate in physiologic and pathologic temperature elevations in man. (C.H.)

**31668** (ACRH-23(p.158-69)) ESTROGEN PHARMACOLOGY. I. THE INFLUENCE OF ESTRADIOL AND ESTRIOL ON HEPATIC DISPOSAL OF SULFOBROMOPHTHALEIN (BSP) IN MAN. Mueller, M. N.; Kappas, A. (Argonne Cancer Research Hospital, Chicago, Ill.).

The influence of natural estrogens on liver function, with special reference to sulfobromophthalein (BSP) excretion, was investigated in man. Pharmacological amounts of the hormone estradiol consistently induced alterations in BSP disposal which were shown to result from profound depression of the hepatic secretory transport maximum ($T_m$) for the dye. Chromatographic analysis of plasma BSP components revealed increased amounts of BSP conjugates during estrogen as compared with control periods, implying a hormonal effect on cellular processes concerned with transport of dye from hepatocytes into biliary canaliculi. Estriol, an in vivo transformation product of estradiol, also impaired hepatic disposal of BSP in man. Esterone, ethinyl estradiol, and equine estrogens have been found to act similarly and it is likely that other C-18 steroids of both physiologic and synthetic origin have this property as well. These observations define a new biological action of natural estrogens in man, further substantiate the role of the liver as a site of action of these hormones, and probably account, in part, for the impairment of BSP disposals which characterizes pregnancy and the neonatal period. Results are reported for thirty-one patients treated with either estradiol or estriol. Two were males; 29 were females, most of whom were postmenopausal. Estradiol was administered to 25 patients (24 females) in amounts of 5 to 200 mg per day for 3 to 41 days. Estriol was administered to 6 patients (5 female) in amounts of 7 to 40 mg per day for 6 to 10 days. Injections of control vehicle solutions were given to each of 13 patients in amounts of 2 ml per day for 30 days. Liver function tests were performed twice in control periods in all subjects and at frequent intervals during control injections and estrogen treatment. (C.H.)

**31669** (ACRH-23(p.170-74)) ESTROGEN PHARMACOLOGY. II. SUPPRESSION OF EXPERIMENTAL IMMUNE POLYARTHRITIS. Mueller, M. N.; Kappas, A. (Argonne Cancer Research Hospital, Chicago, Ill.).

Steroid hormones significantly diminished the incidence of adjuvant-induced arthritis in rats. This generalized inflammatory joint disease develops in rats after intradermal injection of complete adjuvant and it has been suggested that it is immunological in nature since it has features of a delayed hypersensitive type of reaction and passive transfer of the arthritis can be effected by living lymphoid cells from sensitized donors. (C.H.)

**31670** (NIRS-3(p.19-56)) BIOLOGICAL STUDIES. Biochemistry and Biophysics; Cytology and Morphology; Physiology; Genetics. (National Inst. of Radiological Sciences, Chiba (Japan)).

Biological research is reported in biochemistry and biophysics, cytology and morphology, physiology, and genetics. Progress is reported in biochemistry and biophysics on: a model for radiation injury; quantum biological approaches to radiation effects on nucleic acids; electronic state and activity of thyroid hormone; the photodynamic inactivation of pneumococcal transforming DNA; the binding of acridine orange to DNA; kinetic studies of the superactivity of polypeptidyl ribonucleases; the effects of ultraviolet radiation on the template properties of polycytidylic acid; in vitro biosynthesis of luteinizing hormone in rat pituitaries; the leukocyte-promoting activity of saliva parotin A; and the biosynthesis of sinigrin II using $^{35}S$ incorporation into sinigrin from $^{35}S$-sodium sulfate. Studies in cytology and morphology included investigations of: x radioinduced changes in rat thymocytes; the behavior of telophase chromosome groups a binucleate cell following microbeam irradiation; cytological effects of radiation on silkworm spermatogonia; the effects of gamma irradiation on the development of Artemia eggs; the inhibitory effects of chloramphenicol on the histogenetic aggregation of dissociated cells; and chromosomes of a rabbit endothelial cell line in the 101st passage. Physiological phenomena studied were: the influence of temperature on the survival time and development of histopathological changes in the intestine of irradiated Carassius auratus; the effect of temperature on the development of histological damage of hematopoietic tissue following whole-body irradiation of Carassius; the effects of hypophysectomy and adrenalectomy on the length of survival time after x-irradiation in Carassius; melanophore responses to $Na^+$, $k^+$ atropine, and adrenaline in fins of x-irradiated Carassius; radiation effects on the transplantability of the fin in Carassius; radiation effects on embryonic development of skeletal structure in Oryzias latipes; inhibitory effects of x rays on ovary growth in Oryzias during sexually inactive seasons; the relationship between survival time and radiation dose in rat thymocytes; effects of temperature on the progress of radiation death in rat thymocytes; effects of $^{32}P$ transmutation on development in Artemia eggs; changes in lactic acid production of developing Bufo vulgaris embryos; effects of x-irradiation on steroid-producing glands; comparative histology of rectal glands in marine and freshwater sharks; effects of mammalian ACTH on blood sugar content and adrenal histology in goldfish; and splenic and thymic weight response to whole-body x-irradiation in three strains of mice. Genetic research included: mutation induction by acridine orange and visible light in Escherichia coli; effects of chronic irradiation on sex-linked lethal mutation frequencies in Drosophila; comparison of frequency patterns between whole-body and fractional mutations radioinduced in Drosophila; modification of x-ray induced visible mutation frequencies by chromosome structure; effects of nitrogen on mutation rates in x-irradiated germ cells of Drosophila; effects of penicillin feeding on reduction of radioinduced mutation rates in Drosophila; effects of temperature and genetic background on the pre-adult viability of lethal heterozygotes in Drosophila; genetic effects of x rays on the quantitative characters in a heterozygous population; effects of linkage and epistasis on equilibrium frequencies of lethal genes; and inbreeding in subdivided populations. (H.G.D.)

**31671** (NIRS-3(p.57-63)) MEDICAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

Progress in medical research is reported on: hemodynamic studies of the regional renal circulation using radioisotopes, electron microscopy, and histopathological techniques; $^{90}Sr$ removal from bones with parathyroid hormone and chelating substances; plasma albumin turnover and gastrointestinal leakage in carcinoma patients; the value of isotope-renograms in diagnosing ureter strictures in cervical carcinoma patients; chromosome abnormalities in leukocytes of thorotrast-injected persons; and erythrocyte enzyme deficiency and hemolysis. (H.G.D.)

**31672** (NIRS-3(p.65-77)) ENVIRONMENTAL STUDIES. (National Inst. of Radiological Sciences, Chiba (Japan)).

Environmental research included: measurement of the external radiation dose from fallout deposited on the ground surface at Chiba, Japan; dose rate measurements of naturally occurring radiations in buildings and at streets in densely populated areas; $^{14}C$ and $^{3}H$ measurements with a color-quenched, liquid scintillation spectrometer; Sr–Ca discrimination during reabsorption by newts renal tubules; methods for determining $^{131}I$ in fresh milk; $^{137}Cs$ and $^{90}Sr$ concentrations in river water in Japan; radiation decontamination of potable rain water; and $^{90}Sr$ assay in human bone in Japan 1961–1963. (H.G.D.)

**31673** (ORNL-3768) BIOLOGY DIVISION SEMIANNUAL PROGRESS REPORT FOR THE PERIOD ENDING FEBRUARY 15, 1965. (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 205p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

Separate abstracts were prepared for the 22 sections of the research report in radiobiology. (H.G.D.)

*For abstracts of individual sections see: 31674, 31675, 31676, 31677, 31678, 31679, 31680, 31681, 31703, 31704, 31705, 31788, 31789, 31790, 31791, 31792, 31793, 31794, 31795, 31796, 31905, and 31906.*

**31674** (ORNL-3768(p.64-9)) CYTOCHEMISTRY AND CELL REPRODUCTION. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: comparison of tryptophan synthetase from yeast and Neurospora;

visible mutation frequencies induced in Mormoniella oocytes by x radiation; the black eye colors of Mormoniella; metabolic regulation of the DNA-synthetic period in Tetrahymena; and spatial distribution of dividing and DNA-synthesizing cells in mouse epithelium. (H.G.D.)

**31675** (ORNL-3768(p.70-84)) CELL GROWTH AND DIFFERENTIATION. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: dissociation and molecular weight of β-lipovitellin; fine structure of lampbush chromosomes; a stable mitochondrial DNA in Tetrahymena pyriformis; DNA synthesis during embryonic induction; pattern of protein synthesis during embryonic induction; enhancement of RNA synthesis in the cells during Wolffian lens regeneration; progressive changes in the pattern of RNA synthesis during different phases of cellular transformation in Wolffian lens regeneration; temporal sequence of DNA synthesis and tissue specific-protein synthesis in the newt lens regenerate studied by immunofluorescent radioautography; the nucleolus and RNA synthesis during the development of marine invertebrates; and intranuclear crystal within the ovarian phagocytes of Arbacia punctulata. (H.G.D.)

**31676** (ORNL-3768(p.112-18)) RADIATION IMMUNOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: the suppressive effect of supraoptimum doses of antigen on the secondary antibody-forming response of spleen cultured in cell-impermeable diffusion chambers; variation in the kinetic indices of plasma cells in antibody response; antigen competition as an index of differentiative status of immunologically competent cells; recovery of the secondary antibody-forming potential of spleen cells after x irradiation; the radioresistant nature of phagocytic cells; helix-coil transformations of polyuridylic acid; and immunology of grasshopper neuroblasts. (H.G.D.)

**31677** (ORNL-3768(p.119-30)) PATHOLOGY AND PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: life shortening in RF female mice irradiated with 14-Mev neutrons; duration of donor sensitization in the parent-to-$F_1$ foreign spleen reaction; viral induction of myeloid leukemia (inhibition by estrogen); maturation of rat megakaryocytes studied by microspectrophotometric measurements of DNA; the strength of the H-2 controlled hybrid resistance; a second case of hybrid resistance to parental marrow grafts (association with sex); stem cells and lymphocytes in mouse bone marrow; influence of age and the germ-free state on mouse peripheral blood cells; in vitro cytopathogenic effects associated with the Rauscher leukemia virus; the RNA metabolism of leukemic cells; and discontinuous vertical flat-bed electrophoresis in acrylamide gel. (H.G.D.)

**31678** (ORNL-3768(p.137-45)) CHEMICAL CO-CARCINOGENESIS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: efforts to transmit synthetic genetic information using the Shope virus DNA as a carrier; the structure and mechanism of action of the Shope virus; the role of the Shope virus in transducing rabbit genetic information; protection and recovery for chemical damage; cytological effects of phleomycin; inhalation co-carcinogenesis; time relationship of actinomycin D and antigen to the immune response; benzpyrene uptake by bacteria and yeast in the absence of mutation; and the physiology of the virus-host interaction. (H.G.D.)

**31679** (ORNL-3768(p.146-8)) SUBCELLULAR AND VIRAL PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: respiration of synchronized Tetrahymena pyriformis; a long-lived RNA in synchronized T. pyriformis; the effects of actinomycin D on the ribosomes of synchronized Tetrahymena; separation of acid-soluble nucleotides and related compounds from Tetrahymena during various growth conditions; and isolation of macroglobulins by zonal centrifugation. (H.G.D.)

**31680** (ORNL-3768(p.149-53)) NIH-AEC ZONAL ULTRACENTRIFUGE DEVELOPMENT PROGRAM. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: isolation of native glycogen by combined rate-zonal and isopycnic centrifugation; lipid peroxidation in rat tissue particulates separated by zonal centrifugation; and myxovirus and rhinovirus isolation by continuous-flow centrifugation. (H.G.D.)

**31681** (ORNL-3768(p.164-76)) ENZYMOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: the cell-free synthesis of β-galactosidase; amino acid incorporation by extracts of Escherichia coli; isolation and purification of amino-acid-activating enzymes; isolation and purification of specific transfer RNA from E. coli; polyribosome formation and amino acid incorporation during liver regeneration; problem of the determination of the half-life of messenger RNA in rat liver by means of actinomycin D; protein synthesis by preparation from livers of the rainbow trout; the incorporation of $^{14}C$-UTP into RNA of isolated trout liver nuclei; the effect of light on protein synthesis in plants; the effect of actinomycin D on the immune response to two antigens given in sequence; lactic acid dehydrogenase activity as an indicator of rat erythrocytes during the immune response; crystalline bacterial luciferase from Photobacterium fisheri; stimulation of transfer RNA synthesis by steroid hormones; growth hormone effects on hepatic RNA and enzyme synthesis; selective degradation of fast turnover enzymes of liver; hormonal enzyme induction in the reuber hepatoma; and alcohol dehydrogenase in Drosophila (isozymes and their genetic control). (H.G.D.)

**31682** (UCRL-11833) SEMIANNUAL REPORT — BIOLOGY AND MEDICINE, FALL 1964. Lawrence, John H. (ed.) (Lawrence Radiation Lab., Univ. of California, Berkeley). Contract W-7405-eng-48. 163p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Reports on progress in fourteen projects are presented. Separate abstracts were prepared for 12; the remaining two were previously abstracted in NSA, see Vol. 19: 15067 and 15653. (H.G.D.)

*For abstracts of individual sections see: 31683, 31684, 31706, 31707, 31708, 31709, 31710, 31797, 31798, 31799, 32250, and 32669.*

**31683** (UCRL-11833(p.26-8)) A NOVEL METHOD FOR THE RELEASE OF BACTERIOPHAGE DNA. Freifelder, David (Lawrence Radiation Lab., Univ. of California, Berkeley).

A technique for extracting nucleic acids from animal and plant viruses and from bacteria is described. DNA was extracted from coliphages T4, T7, and λ, and from Pseudomonas aeruginosa phage B3 by adding a phage suspension to a 5M $NaClO_4$ solution containing $5 \times 10^{-3}$M EDTA, mixing, and waiting until DNA release occurs. Transforming DNA was extracted with 2M $NaClO_4$ from B. subtilis phage SP50. (H.G.D.)

**31684** (UCRL-11833(p.29-33)) THE EFFECT OF LITTER CULLING, OR FAMILY PLANNING, ON THE RATE OF NATURAL SELECTION. King, Jack Lester (Lawrence Radiation Lab., Univ. of California).

Familial selection, or the arbitrary limitation of the number of progeny of each mating pair in a population (as by litter culling or family planning), reduces the rate of natural selection by eliminating between-family selection. Selection against recessive early lethals is reduced to about two-thirds of the rate predicted with true panmixis; the rates of selection against rare recessive, additive and dominant deleterious alleles, with small individual effects on viability, are nearly halved. Selection rates against alleles affecting fecundity are likely to be still more sharply reduced. (auth)

**31685** RADIOACTIVE POLLUTION. BIOLOGICAL EVOLUTION. Michon, G. Maroc Med., 43: 167-76(1964).

The origin of radioactive pollution from human industry,

methods of emitting radioactive dusts and gases, evacuation of residues in water currents, storage of radioactive elements, and the physicochemical behavior of radioisotopes are discussed. The behavior of radioelements in atmosphere, water, and soil is reviewed. A study of the biological cycle of radioelements, including processes of dilution and concentration in living organisms, and relationships with ambient factors and with factors of animal and vegetal vitality is described. (TCO)

**31686** EFFECTS OF ISOTOPIC SUBSTITUTION ON ELECTRON SPIN RESONANCE SIGNALS IN PHOTOSYNTHETIC ORGANISMS. Kohl, Daniel H. (Washington Univ., St. Louis); Townsend, Jonathan; Commoner, Barry; Crespi, Henry L.; Dougherty, Ralph C; Katz, Joseph J. Nature, 206: 1105-10(June 12, 1965).

Studies were made of the effects of isotopic substitution on electron spin resonance spectra of a series of photosynthetic organisms. The organisms were grown so as to achieve virtually total deuteration of the culture. In addition preparations of Rhodospirillum rubum were grown with partial replacements of $^{12}C$ by $^{13}C$ and Chlorella vulgaris was grown in a medium in which all the available nitrogen was supplied as 95% $^{15}N$. In each of the organisms (bacteria and algae) examined, the peak-to-peak width of the predominant light response was decreased by massive deuterium substitution, usually by a factor of 2 to 3. No $^{13}C$ and $^{15}N$ effects were observed. The hyperfine structure seen in normal protonated organisms was not observed with deuterated organisms. Data are presented in graphs. (M.C.G.)

**31687** THE EFFECT OF RADIOTOXINS TO THE INTRAUTERINE FOETAL EVOLUTION IN RATS. Czeizel, E.; Majorossy, K.; Keresztes, M.; Georgenyi, A. (Medical Univ., Budapest). Radiobiol. Radiotherap., 6: 271-3(1965). (In German)

Pregnant rats were intraperitoneally injected with suspension of bone-marrow five times in the preimplantation period. As a result the number of rat fetuses decreased. In organogeny no evaluative effect could be caused with this treatment. (tr-auth)

**31688** RADIOISOTOPES IN ANIMAL NUTRITION AND PHYSIOLOGY. Proceedings of the Symposium held in Prague, November 23-27, 1964. (International Atomic Energy Agency, Vienna (Austria)). Proceedings Series. Feb. 1965. 881p. (STI/PUB/90; CONF-641105). $9.00; S 189,-; £2.14.0; F.Fr.36,-; DM 31,50(IAEA).

Separate abstracts were prepared for eleven papers. Two papers were abstracted previously and appeared in NSA Vol. 19: 8739 and 15007. (C.H.)

*For abstracts of individual papers see: 31689, 31749, 31750, 31751, 31752, 31753, 31754, 31755, 31756, 31757, and 31758.*

**31689** THE ESTIMATION OF CAPILLARY CIRCULATION OF THE MUSCLE IN ANIMALS BY Xe-133. Prerovsky, J.; Hlavova, A.; Vavrejn, B. (Institute for Cardiovascular Research, Prague and Institute for Clinical and Experimental Surgery, Prague). p.631-41 of STI/PUB/90.

The clearance of $^{133}Xe$ in muscle was compared in experiments on 11 dogs with the blood flow measured rotametrically. The experiments were performed on the abductor muscles in skinned leg preparation and completely isolated from the remaining circulation. The femoral artery constituted the only source of blood supply for the investigated muscle. Xenon-133 was injected about two cm deep into the muscle group in a volume of 0.1 ml, the average activity being 50 to 100 microC. For the detection a scintillation probe was used (crystal 1 × 1 inch) with a screening 2.5 cm, with a cylindrical collimator 5 cm long and with a diameter of 2.5 cm. The impulses were read off each minute and the slope of the clearance was determined for each analysed portion of the curves; the absolute values were calculated according to Munck and Lassen and the results expressed in flow per volume unit of the leg. Results are given describing the values at rest and during the occlusion of the artery. It was found that clearance $^{133}Xe$ values represent 30 to 60% of the volumetrically obtained values. On the other hand during partial occlusion of the artery the coefficient expressing the ratio between the two values approached 1. It was concluded that the clearance of $^{133}Xe$ represents the capillary flow values and the values obtained by the rotameter are higher by including the shunting circulatory bed. This portion seems to decrease to negligible amounts during tissue ischemia and hence it is possible to explain that under these conditions the ratio between the values obtained by the two described methods approaches to 1. Applications of these results for the determination of capillary flow by clearance of $^{133}Xe$ are described. (auth)

**31690** AEC LICENSING OF RADIOISOTOPES FOR CLINICAL RESEARCH. LeRoy, George V. (Univ. of Chicago). p.193-200 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

The prevention of unnecessary exposure to radiation in clinical research is discussed. The granting of licenses is based on the design of the experiment, the dose of radiation expected under the conditions of the experiment, the resources of the laboratory supporting the clinical study, and the extent of the applicant's experience in clinical research and in the use of radioisotopes. The following problem areas in clinical research are considered: experiments with pregnant women and children, the amount of radioisotope that may be used, uses of $^{14}C$, and tritium-labeled thymidine. (M.C.G.)

**31691** DIISOPROPYLFLUOROPHOSPHATE-$P^{32}$ (DFP-$P^{32}$) AS A LABEL FOR GRANULOCYTES. Raab, Spencer O. (Univ. of Utah, Salt Lake City). p.261-6 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

The use of diisopropylfluorophosphate (DFP) labeled with $^{32}P$ for labeling granulocytes is discussed. Maximum labeling was obtained in 45 min. The viability of DFP-$^{32}P$-labeled granulocytes was the same as that of unlabeled cells. The label was not reutilized when the cells were degraded and election was not observed. Blood is withdrawn into a plastic transfusion bag and DFP-$^{32}P$ is added in a concentration of 0.3μg/ml of whole blood, and the mixture incubated at room temperature for 1 hr. At the end of this time, three aliquots are removed from the bag for determination of granulocyte radioactivity, and the remaining known quantity of blood is infused back into the donor. The size of the total blood granulocyte pool can be measured by means of the isotope dilution principle. The rate of disappearance of granulocytes from circulation can be followed. (M.C.G.)

**31692** CLINICAL USE OF LIQUID-TYPE WHOLE-BODY RADIOACTIVITY DETECTORS. Heinrich, Hellmuth C. (Universitat, Hamburg). p.267-76 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

A module-type 4π whole-body radioactivity detector with a liquid organic scintillator in combination with a large NaI-crystal detector is described. The application of whole-body detectors with liquid organic scintillators in biomedical research and clinical diagnosis is discussed. Advantages and disadvantages of five diagnostic $^{60}Co$-Vitamin-$B_{12}$ absorption tests were surveyed using whole-body detectors. (M.C.G.)

**31693** PAIRED LABELING WITH $I^{125}$ AND $I^{131}$. Pressman, David (Roswell Park Memorial Inst., Buffalo). p.277-8 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

Studies are being made with antibodies, which localize preferentially in particular organs and in tumors. Where these antibodies are fixed is determined by labeling them with radioactive iodine and determining the localization of the radioactivity. Control experiments are important to ascertain that the labeled antibodies are picked up specifically rather than nonspecifically. It was found to be possible to get good control by injecting antibodies labeled with $^{131}I$ and control preparation labeled with $^{125}I$. The two preparations are injected simultaneously and each piece of tis-

sue can be assayed for control localization along with antibody localization. (M.C.G.)

**31694** PROGRESS IN NUCLEIC ACID RESEARCH. VOLUME 1. Davidson, J. N.; Cohn, Waldo E. (eds.). New York, Academic Press, 1963. 434p. $13.00.

Eleven sections are included; separate abstracts were prepared for 2. The remaining 9 sections not abstracted separately in NSA include information on: biosynthesis of RNA in animal systems; role of DNA in RNA synthesis; polynucleotide phosphorylase; messenger RNA; recent excitement in the coding problem; double-stranded model of DNA; denaturation and renaturation of DNA; macromolecular structure of RNA; and structure of DNA as determined by x-ray scattering techniques. (P.C.H.)

*For abstracts of individual sections see: 31892 and 31893.*

**31695** A SURVEY OF THE STATUS OF CLOSTRIDIUM BOTULINUM RESEARCH. Anderson, A. W. (Oregon State Univ., Corvallis). pp 217-22 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Clostridium botulinum Type E appears to be of terrestrial origin and to have a world-wide distribution. Its concentration is more-or-less proportional to the land mass. Unlike Clostridium botulinum Types A and B, its low-heat sensitivity precludes heating during initial isolation. The development of a selective medium makes it possible to isolate the clostridia directly, and fluorescent staining permits rapid differentiation of the strains of Clostridium botulinum on the basis of their proteolytic and nonproteolytic activity. (auth)

**31696** IAEA LABORATORY ACTIVITIES. SECOND REPORT. (International Atomic Energy Agency, Vienna (Austria)). Technical Reports Series No. 41. 1965. 113p. STI/DOC/10/41 $1.00; S21,-; 6/-stg; F.Fr.4-; DM 3,20 (IAEA).

Developments and scientific work during 1964 at Vienna and Seibersdorf are described. Work in physics, chemistry, low-level radioactivity, agriculture, and medical physics is summarized. Production and analysis of tritium are described along with electronic and mechanical developments. Tables of isotopic standards, analytical results and other measurements are included. Activities at the Monaco Marine Radioactivity Laboratory are reported along with those at the Trieste Theoretical Physics Center and the Middle Eastern Radioisotope Center for Arab Countries. (J.R.D.)

## Ecology

*Refer also to abstract 32423.*

**31697** (EUR-2436.e) STUDY ON THE BIOLOGY OF THE FISH IN THE LAGO MAGGIORE WITH THE AIM OF COLLECTING DATA AS A BASIS FOR FORECASTING THE POSSIBLE INTERACTIONS BETWEEN THESE FISH AND THE RADIOACTIVITY IN THE LAKE WATER. Biology of the Fishes in the Lago Maggiore. I. Coregonids (Coregonus Sp.). Annual Report, 1964. Berg, A. (European Atomic Energy Community); Grimaldi, E. (Istituto Italiano di Idrobiologia, Pallanza). June 1965. 32p. Dep.(mn).

Investigations were carried out on various aspects of the two coregonids (Coregonus sp.) introduced and now living in the Lago Maggiore (N. Italy). The results presented are successively concerned with origin, morphological characteristics, feeding habits, annual and seasonal growth, fecundity, and distribution. (EURATOM)

**31698** (HW-SA-3556) PITFALL TRAPPING SURVEY OF AUTUMN-EMERGING DARKLING BEETLES IN DESERT STEPPE VEGETATION. Rickard, W. H.; Haverfield, L. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). [May 28, 1964]. Contract AT(45-1)-1350. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A continuous pitfall trapping survey of the autumn-emerging darkling beetles, Pelecyphorus densicollis Horn. and Stenomorpha puncticollis Le C., was made in adjacent greasewood and sagebrush communities on the Hanford Reservation, Benton County, Washington in 1963. A total of 4,378 beetles were captured, marked, and released. Potassium was the dominant cation measured in samples of whole beetles. Beetles of the greasewood community tended to be higher in cations than those of the sagebrush community, especially in regard to sodium. Cesium-137, a long-lived gamma emitting constituent of worldwide fallout, was measured in greasewood and sagebrush leaves but not in beetles. (C.H.)

## Metabolism, Tissue Distribution, and Toxicology

*Refer also to abstracts 32067, 32271, 32272, 32421, 32424, and 32593.*

**31699** (ACRH-23(p.21-32)) PHYSIOLOGICAL STUDIES OF PRIMITIVE HEMOPOIETIC CELLS. Gurney, C. W.; Hofstra, D.; Mangalik, A. (Argonne Cancer Research Hospital, Chicago, Ill.).

The mechanism by which the compartment of primitive cells can maintain itself in the face of continued loss due to differentiation, or can quickly recover when most of its cells have been damaged by irradiation or chemicals, should be of great interest to hematologists. A break-down of this regulatory mechanism, leading to continuous and autonomous proliferation of primitive cells may be relevant to the etiology and pathogenesis of an untreatable condition currently recognized by practicing hematologists with unfortunate frequency. Results are reported from three series of tracer investigations in mice that suggest that the erythropoietin-responsive cell (ERC) is multipotential, although admittedly this hypothesis cannot yet be considered as established beyond a doubt. These studies reflect the proliferative potential of a primitive cell of the mouse hemopoietic system. Erythropoietin has been used as a tool because it can be applied as a quantitative stimulus to this primitive compartment, the response to which can be measured with precision by radioiron. These studies suggest that the erythropoietin responsive cell is in a dynamic pool even when erythropoiesis has been eliminated by hypertransfusion, and that the number of erythropoietin responsive cells tends to remain approximately constant. That is to say, a homeostatic mechanism exists which tends to maintain this compartment. If most of the erythropoietin responsive cells in the animal have been damaged by radiation, forces come into play which tend to restore the cell number to normal. If a large dose of radiation destroys all but a cluster of protected cells, this cluster very promptly receives a message that initiates proliferation, and the cells quickly increase in number. When they are of splenic origin these cells tend to remain in the spleen for a short time, but after 24 hours their number in the spleen drops, and this fall precedes the appearance of erythropoietin responsive cells in the spine and femurs five days after the damage has been sustained. (C.H.)

**31700** (ACRH-23(p.33-9)) QUANTITATION OF THE ERYTHROPOIETIC STIMULUS PRODUCED BY HYPOXIA IN THE PLETHORIC MOUSE. Gurney, C. W.; Munt, P.; Brazell, I.; Hofstra, D. (Argonne Cancer Research Hospital, Ill.).

Results are reported from a study of the minimum period of hypoxia required to activate the organ of erythropoietin production in the mouse. Carworth Farms No. 1 virgin female mice, 7 to 9 weeks of age, were given 1 mg of Proferrin intraperitoneally. Plethora was then induced by residence in a pressure chamber except for approximately 0.25 hour at ambient conditions 2 times weekly for cage maintenance and change of water. Following several days at ambient conditions, to permit maturation of erythroblasts already in cycle, a fresh wave of erythropoiesis was

initiated by a single injection of erythropoietin, a return to the chamber, or a combination of both. Forty-eight hours later, 0.5 μC of $^{59}FeCl_3$ in a volume of 0.2 ml was administered intravenously. In 2 experiments, the radioiron was brought to the desired volume by addition of a mixture of 1 part post-phlebotomy anemic mouse plasma to 4 parts of saline. In the remaining experiments, the radioiron was brought to volume with saline. Seventy-two hours later a measured volume of blood from the thoracic aorta was taken for scintillation well counting. From activity of a standard prepared at the time of radioiron injection, and assuming a blood volume of 7% of the body weight for these animals, the percentage of the injected radioiron in newly formed peripheral red cells was determined. It is assumed that this value is proportional to effective erythropoiesis, since both the radioiron incorporation of newly formed erythrocytes and the reticulocyte response in plethoric mice are functions of the amount of erythropoietin administered to these animals over a wide range of dose. Normal mice approached a new hematological equilibrium after approximately 3 weeks at a pressure of 0.5 atmosphere, a condition simulating an altitude of 18,000 feet. Longer periods of hypoxia did not further increase the hematocrit of blood from the tail vein, although the red cell mass and the plasma volume may have continued to increase after the hemoglobin concentration was stabilized in a hypoxic environment. It was concluded that once the plethoric state is established, an environmental pressure of 0.5 atmospheres no longer produces the striking hypoxic stress exerted by exposure without previous acclimatization. Following return to ambient conditions, the abundance of blood relative to need is such that erythropoiesis is reduced markedly. Possible reaction mechanisms involved are discussed. (C.H.)

**31701** (COO-587-2) Ca-45 AND Sr-85 METABOLISM IN MAN. Final Progress Report, May 1, 1958–March 31, 1965. (Creighton Univ., Omaha, Nebr. School of Medicine). Contract AT(11-1)-587. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in studies of bone metabolism and derangements therein found in bone diseases of man in which $^{45}Ca$ and $^{85}Sr$ were used as tracers. An extremity counter utilizing a plastic scintillation detector was used in counting and data were analyzed by a computer. A technique was developed for calculation of the exchangeable Ca in a given 3-in. segment as grams of Ca and of accretion as grams of Ca per day so that the absolute contribution of individual peripheral bone regions to the total body kinetic analyses can be derived. Results show that periarthritic bone usually has a higher initial uptake than normal bone, despite lower plasma specific activity, and the rate of fall of activity in arthritic bone is less rapid than in normal regions, indicating an increase in bone exchangeability and accelerated new bone formation in periarthritic bone. Data are summarized from Ca balance and $^{45}Ca$ kinetic studies in patients with osteoporosis; calcium metabolism studies in patients with combined central osteoporosis and peripheral rheumatoid arthritis; and metabolic balance and $^{45}Ca$ studies in normal subjects, hypopituitary dwarfs, hypopituitary adults, and an adult with active acromegaly. A list is included of publications resulting from these studies. (C.H.)

**31702** (NP-15072(p.1-16)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. I. STUDIES ON THE TOXICITY AND MECHANISM OF ACTION OF 2-MERCAPTOETHYLAMINE (MEA). Yam, Kei-Ming; DuBois, Kenneth P. (Chicago Univ., Ill. Air Force Radiation Lab.).

The administration of chlorpromazine (12 mgm/kgm) 45 minutes before 250 mgm/kgm of MEA protected rats from the acute toxic effects of MEA. This dose of chlorpromazine did not protect against higher doses of MEA. Administration of ether whenever animals began to convulse following 250 mgm/kgm of MEA effectively controlled the convulsions. It was necessary to carry out the ether treatment for 5 hours to obtain 100% survival. With a higher dose of MEA (350 mgm/kgm) convulsions still occurred when ether treatment was withdrawn after 7 hours indicating a rather prolonged action of a single dose of MEA. The intraperitoneal injection of 500 mgm/kgm of magnesium sulfate 30 minutes before the administration of 275 mgm/kgm of MEA protected all of the animals from the acute lethal effects of MEA. Magnesium sulfate did not offer much protection against higher doses of MEA. Treatment of rats with calcium lactate had no beneficial effect against MEA toxicity and the highest dose of calcium seemed to accentuate the toxicity of MEA. Treatment of animals with pyridoxine (15 mgm/kgm) had no beneficial effect of the toxicity of MEA. AET (150 mgm/kgm) in combination with MEA (250 mgm/kgm) resulted in increased toxicity since these doses of either drug given alone produce no mortality. Examination of the toxicity of MEA to adult male and female rats demonstrated that there is no sex difference as indicated by an approximate $LD_{50}$ of 250 mgm/kgm for both sexes. The inhibitor of microsomal enzyme activity (β-diethylamine ethyldiphenylpropyl acetate) slightly enhanced survival from 250 mgm/kgm of MEA at a dose level of 20 mgm/kgm but a higher dose potentiated the acute toxicity of MEA. Rats given 25 mgm/kgm of phenobarbital twice a day for 3 days were protected against mortality from doses as high as 300 mgm/kgm of MEA. Treatment of rats with chlorpromazine appeared to decrease somewhat the protective effect of 200 mgm/kgm of MEA. (auth)

**31703** (ORNL-3768(p.154-6)) NUCLEIC ACID CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Research progress is reported on: ion exchange chromatography of oligonucleotides; biosynthetic polydeoxynucleotides; biological properties of synthetic polydeoxynucleotides; and the enzymatic synthesis and degradation of DNA in Micrococcus lysodeikticus. (H.G.D.)

**31704** (ORNL-3768(p.157-63)) NUCLEIC ACID ENZYMOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: biochemical transformation of bacteriophage $T_2$ DNA; purification and characterization of the oligodeoxyribonucleotide transferase system; bioxynthesis of RNA bacteriophage R17 (effect of 5-fluorouracil incorporation); a unique aminoacyl-sRNA synthetase; coding properties of anomalous charged sRNA's; aminoacyl-sRNA binding properties of biosynthetic polynucleotides; separation of transfer ribonucleic acids by a simple extraction process; nucleotide and nucleic acid metabolism in normal and hybrid amphibian embryos; studies on RNA polymerase from amphibian liver; and occurrence of $P^1,P^3$-diguanosine 5′-triphosphate in brine shrimp eggs. (H.G.D.)

**31705** (ORNL-3768(p.177-8)) MICROBIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: the chemical structure of the Streptococcus faecalis naphthoquinone; thioether formation between 2-solanesyl-1,4-naphthoquinone and 2-mercaptoethanol; and localization of electron transport components in Streptococcus faecalis. (H.G.D.)

**31706** (UCRL-11833(p.34-49)) FURTHER DEVELOPMENT OF A SINGLE-TRACER INJECTION METHOD FOR $C^{14}$-GLUCOSE KINETIC STUDIES IN HUMANS. Manougian, Edward (Lawrence Radiation Lab., Univ. of California, Berkeley).

The model for the study of glucose kinetics originated by Baker et al. is expanded and refined both in its theory and in its realization. The present paper is concerned with the refinements in theory. A subsequent report will present the data obtained when this method was applied to the study of normal individuals as well as patients with acromegaly or diabetes mellitus. (auth)

**31707** (UCRL-11833(p.50-72)) $C^{14}$-GLUCOSE KINETIC STUDIES IN NORMAL, DIABETIC AND ACROMEGALIC SUBJECTS. Manougian, Edward; Pollycove, Myron; Linfoot, John A.; Lawrence, John H. (Lawrence Radiation Lab., Univ. of California, Berkeley).

The results obtained by using the single injection tracer method of Baker et al., as modified by Tolbert et al., for

the study of glucose kinetics in humans are presented for normal subjects, diabetic patients, and acromegalic patients. The latter two categories contain individuals who had studies performed before and/or after heavy-particle irradiation to the pituitary gland. The results indicate similar deviations from normal for both the diabetic and the acromegalic patients. These deviations are more marked in diabetes mellitus than in uncomplicated acromegaly and consist of prolongation of the radiobiological half-life of glucose $^{14}C$, diminution of the fractional turnover rate of glucose, enlargement of the glucose-pool size and lowering of the oxidation rate of glucose to $CO_2$. The deviations in acromegaly can be reversed by heavy-particle pituitary irradiation. However, the effect of pituitary irradiation on th $^{14}C$-glucose kinetic pattern of adult diabetic subjects seems to be an elevation in glucose turnover without other significant changes. Further studies are required on irradiated diabetic and acromegalic subjects before more definite statements can be made. The rise in glucose turnover that accompanies the rise in blood glucose appears to be limited, a decline in turnover being observed for blood-glucose values above 370 mg/100 ml. Further support for the model of Baker et al., was obtained through the agreement of the theoretically predicted $t_{max}$ and the actually observed $t_{max}$ for the $CO_2$ specific activity curves. (auth)

**31708** (UCRL-11833(p.100-11)) BONE BLOOD FLOW SHOWN WITH $F^{18}$ AND THE POSITRON CAMERA. Van Dyke, Donald; Anger, Hal O.; Yano, Yukio; Bozzini, Carlos (Lawrence Radiation Lab., Univ. of California, Berkeley).

Development of the positron camera made it possible to rapidly obtain pictures of the distribution of radioactive $^{18}F$ in living animals or man. The distribution of $^{18}F$ administered intravenously as fluoride ion is uneven in the normal skeleton. Furthermore, it is markedly altered in pathological conditions and accumulates at fracture sites, tumor sites, and in the lesions of Paget's disease. The initial uptake of fluoride in bone is dependent on the rate of delivery of the isotope to each bone (blood-perfusion rate) and the extraction efficiency of that bone. Evidence is presented indicating the fluoride distribution in the skeleton is determined by differences in blood-perfusion rate to the various bones rather than differences in extraction efficiency. It is suggested that $^{18}F$ distribution is an indicator of blood flow to bone. (auth)

**31709** (UCRL-11833(p.134-44)) SERUM LIPID-LIPOPROTEIN INTERRELATIONSHIPS BETWEEN MALES AND FEMALES. Freeman, Norman K.; Lindgren, Frank T.; Ewing, Alicia M. (Lawrence Radiation Lab., Univ. of California, Berkeley).

Lipid and lipoprotein analyses were carried out on the sera of 16 normal females ranging in age from 35 to 49 years. These data were combined and compared with previous results on normal males of the same age range. With computer methods, concentrations were determined for 44 lipoprotein subclasses. This permits the construction and comparison of mean lipoprotein profiles for male and female groups. In each group, correlations have been examined between concentrations of the subclasses and the $S_f^0$-rate of the major low-density lipoprotein peak. Correlation coefficients were also tabulated for all pairs of 22 selected variables in each sex group. Some correlations of particular interest are discussed. (auth)

**31710** (UCRL-11833(p.145-53)) THE EFFECT OF VERY LOW-DENSITY LIPOPROTEINS ON LIPID TRANSFER IN INCUBATED SERUM. Nichols, Alex V.; Smith, Lester (Lawrence Radiation Lab., Univ. of California, Berkeley).

Incubation of human serum solutions low in glyceride content for 16 hr resulted in a net increase of cholesteryl esters in all three major human serum-lipoprotein classes, very low-density lipoproteins of d < 1.006 (VLDL), low-density lipoproteins of d 1.006-1.063 (LDL) and high-density lipoproteins of d 1.063-1.21 (HDL). Transfer of glycerides from the VLDL to the LDL and HDL was also observed during incubation. Reductions in lipoprotein unesterified cholesterol and phospholipids occurred during incubation and indicated the presence of serum-fatty acid-transferase activity in these solutions. When serum was incubated in the presence of high concentrations of VLDL lipoproteins, the increase in cholesteryl esters was found only in the VLDL fraction. The VLDL apparently took up newly formed cholesteryl esters produced by serum-fatty acid-transferase activity, and accepted some cholesteryl esters, initially bound to the LDL and HDL. When the transferase was inhibited with sodium p-hydroxymercuribenzoate, some of the cholesteryl esters, initially bound to the LDL and HDL, were still transferred to the VLDL. The HDL class was then the principal contributor of the cholesteryl esters. These observations indicate that reciprocal transfer of cholesteryl esters for glycerides in human serum lipoproteins can occur. (auth)

**31711** (UCRL-14146) I-131, I-133, AND COW MILK. Tamplin, Arthur R. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 10, 1965. Contract W-7405-eng-48. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The literature on the secretion of iodine into cow milk is reviewed with the purpose of developing a state-of-the-art model for the prediction of fallout iodine in cow milk. It was demonstrated that there were no significant mysteries with respect to the secretion of iodine in milk and that the present ability to predict fallout iodine in cow milk is adequate for most practical situations when the level of contamination on the pasture is known. Equations were developed as conservative estimates of the time-course of I-131 and I-133 in cow milk. (C.H.)

**31712** (UR-665) PLUTONIUM UPTAKE BY ANIMALS EXPOSED TO A NON-NUCLEAR DETONATION OF A PLUTONIUM-BEARING WEAPON SIMULANT. PART I. FIELD OPERATIONS. Wilson, R. H.; Terry, J. L. (Rochester Univ., N. Y. Atomic Energy Project). Apr. 14, 1965. Contract W-7405-eng-49. 45p. Dep.(mn); $3.00 (cy), 1(mn) CFSTI.

Operation Roller Coaster was a joint United States–United Kingdom field exercise undertaken to aid in the evaluation of criteria for the storage and transport of plutonium-bearing weapons. The biological studies performed as a part of this Operation consisted of exposing 300 dogs, sheep, and burros on a highly mobile array to the cloud generated by the chemical detonation of a single Pu-bearing weapon. Immediately after cloud passage the exposed animals were recovered and decontaminated and serial sacrifices according to a 3-yr schedule were initiated. Autopsies were performed on all sacrificed animals and tissues were taken for radiochemical analysis, autoradiography, and pathology. Some of the exposed animals were followed for Pu excretion. No results are reported. (C.H.)

**31713** THE LIBERATION OF RADIOIODINE $^{131}I$ FROM THE THYROID GLAND AND OTHER TISSUES BY MEANS OF POTASSIUM PERCHLORATE AND POTASSIUM THIOCYANATE. Dolgova-Korobun, V.; Sestakov, G. (Inst. for Pathophysiology, Yugoslavia). Acta Med. Iugoslav., 16: 336-45(1962). (In Slavic)

The effects of potassium perchlorate and potassium thiocyanate on the thyroid function of ten dogs were investigated by the method of direct blood sampling from the thyroid vein. The results thus obtained showed that the anions $ClO_4^-$ and $SCN^-$ cause a release of $^{131}I$ from the thyroid gland. The amount of radioiodine was so small that it could not be detected in the systemic circulation by surface neck counting, but only in the samples of the blood from the thyroid vein. The anion $ClO_4^-$ caused a release of $^{131}I$ even from a gland previously discharged and blocked by $SCN^-$. This is explained by blocking of the intraglandular cycle of iodine by $SCN^-$, preventing further reutilization of iodine by the gland. In thyroidectomized dogs both potassium perchlorate and thiocyanate caused a release of significant amounts of $^{131}I$ into the systemic circulation. This shows the ability of these anions to remove accumulated iodine ions from nonthyroid tissues. (BBB)

**31714** EXCHANGE OF CALCIUM BETWEEN BLOOD, BRAIN, AND CEREBROSPINAL FLUID. Graziani, Leonard; Escriva, Anthony; Katzman, Robert (Albert Einstein Coll. of Medicine, New York). Am. J. Physiol., 208: 1058-64(June 1965).

Ca exchange was measured in anesthetized cats during steady-state ventriculocisternal perfusions. When $^{45}Ca$ was added to the perfusate the efflux coefficient from CSF averaged 0.025 ml/min of CSF cleared of $^{45}Ca$. This coefficient was independent of CSF Ca concentration, indicating passive diffusion. About one-third of this isotope was recovered in brain tissue, two-thirds presumably diffused into blood. The brain radioactivity was localized to areas immediately adjacent to the CSF pathway. When the isotope was given systemically, the efflux coefficient into the ventricular system averaged 0.015 ml/min of serum effectively cleared of $^{45}Ca$. In these experiments the specific activity of the CSF approached that of the serum. At the same time the specific activity of the brain Ca was low. Hence, the chief source of the Ca entering CSF must be blood. The rate of movement of $^{45}Ca$ from blood to CSF was not altered when CSF formation was suppressed by adding acetazolamide or lowering the pH of the perfusate. This suggests that Ca transport is independent of the bulk fluid formation. (auth)

**31715** RENAL TUBULAR REABSORPTION OF TRACE ALKALINE EARTHS COMPARED WITH CALCIUM. Rahill, W. Joseph; Walser, MacKenzie (Johns Hopkins Univ., Baltimore). Am. J. Physiol., 208: 1165-70(June 1965).

Simultaneous clearances of inulin, calcium, and either $^{7}Be$, $^{140}Ba$, or $^{226}Ra$, given by constant infusion, were measured in salt-depleted dogs or dogs undergoing mild saline, mannitol, or sulfate diuresis. Urine-to-plasma ratios of all three cations less than 0.5 were noted, suggesting that all can be actively reabsorbed. Clearances of barium and radium were correlated with calcium clearance, but the clearance of beryllium was unpredictable. Protein binding of beryllium was shown to be of the same order of magnitude as other alkaline earths when errors due to adsorption of $^{7}Be$ onto containers were minimized. Protein binding of barium averaged 54%. The excreted-to-filtered ratio for barium was a constant power (0.54) of the ratio for calcium. The data do not exclude the possibility that these cations are reabsorbed by a common transport mechanism with calcium. (auth)

**31716** BILE SALT ABSORPTION IN THE IRRADIATED RAT. Sullivan, Maurice F. (Battelle-Northwest, Richland, Wash.). Am. J. Physiol., 209: 158-64(July 1965). (HW-SA-3694)

Measurements of radioactivity in bile secreted by bile duct-cannulated rats after intraluminal injection of the labeled bile salt indicated bile salt absorption rates in the duodenum, ileum, and large intestine in the ratio of 1 : 30 : 2. Three days after exposure of the abdomen to 1,000 or 1,500 R of x-irradiation, absorption from the ileum was decreased by 14 and 53%, respectively. Five days after exposure to 1,500 R, absorption from the ileum was decreased by 70%. Nitrogen mustard also decreased absorption. This was shown to be a radioinduced absorption defect that probably resulted in increased excretion of bile salts, rather than an impaired secretion of bile by the liver, by injecting labeled bile salts intravenously or parenterally. At 4 days after 1,500 R and 1 day after intravenous injection of $^{14}C$-labeled cholic acid, the accumulation of labeled bile salt in the lower bowel was almost twice the unirradiated value. The level of radioactivity secreted in the bile at that time was one-half control value and that present in the small intestine only one-sixth the unirradiated level, suggesting a dilution of the labeled bile salt as a result of de novo synthesis and a substantial accumulation of bile salts in the lower small intestine and large bowel. (auth)

**31717** SYNTHESIS OF 2-AMINO-4-HYDROXY-6-(D-ERYTHRO-1′, 2′, 3′-TRIHYDROXYPROPYL)PTERIDINE-3′-PHOSPHATE-10-$C^{14}$, AND ITS METABOLISM IN DROSOPHILA MELANOGASTER. Goto, Miki; Okada, Tadashi; Forrest, Hugh S. (Tokyo Univ. and Univ. of Texas, Austin). Arch. Biochem. Biophys., 110: 409-12 (June 1965).

The synthesis of (2-amino-4-hydroxy-6-pteridinyl)-glycerol phosphate-10-$^{14}C$ is reported. When this compound is reduced and then fed to Drosophila melanogaster, the major radioactive component isolated is 2-amino-4-hydroxy-6-methylpteridine-10-$^{14}C$. (auth)

**31718** THE ELECTROPHORETIC BEHAVIOUR OF SOME TRYPANOSOMES. Hollingshead, Shelia; Ryley, J. F.; Pethica, B. A. (Manchester Coll., Eng.). Biochem. J., 89: 123-7(Oct. 1963).

Uranyl ion was used to investigate the nature of the surface of trypanosomes. Electrophoretic studies of Trypanosoma rhodesiense (blood and culture forms), and the blood-stream forms of T. congolense, T. equinum, T. lewisi, and T. vivax were conducted. The electrophoretic behavior of trypanosomes at various pH values in the presence and absence of $UO_2^{2+}$ ions suggest that the surface of the culture form of T. rhodesiense and of the blood-stream form of T. lewisi is phosphatide in character, whereas that of the blood-stream form of T. rhodesiense may be of a polysaccharide or polypeptide nature. Thus, uranyl ions caused a charge-reversal with T. rhodesiense (culture form) and T. lewisi at a concentration of 1.0 mM; a low charge-reversal concentration of $UO_2^{2+}$ ions is characteristic of phosphatide and phosphate surfaces. The blood-stream form of T. rhodesiense had an isoelectric point between pH 5.8 and 7.0; thus, at physiological pH, the trypanosome was capable of circulating in an uncharged state or carrying a very small, usually negative, charge. Uranyl ions did not appear to have any effect on the electrophoretic mobility of the trypanosome; the change in mobility brought about by uranyl solutions was due only to the change in pH of the solutions, suggesting that the surface of these organisms is not phosphatide in character. Polysaccharide surfaces give low electrophoretic-mobility values that are independent of pH. Such a surface on the blood-stream form of T. rhodesiense would account for the zero or low mobility observed at pH 7.0, but the pH dependence of the trypanosome mobility suggested the presence of basic and acidic groups in the membrane. The $pK_a$ values of the acidic and basic groups were 5.0 and 9.5, respectively, with both types of group ionized in the neutral pH range, suggestive of carboxyl and amino groups. Comparison of the findings for trypanosomes with those for other cells previously studied shows that T. lewisi is very similar electrophoretically to freely circulating cells such as lymphocytes and tumor cells. On the other hand, the surface properties of the blood-stream form of T. rhodesiense are different electrophoretically from any other freely circulating cell so far studied. (BBB)

**31719** STRONTIUM BALANCE IN BREAST-FED BABIES. Harrison, G. E. (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.); Sutton, Alice; Shepherd, Hilda; Widdowson, Elsie M. Brit. J. Nutr., 19: 111-17(1965).

The Ca and Sr intakes and the urinary and fecal outputs were measured over three days in 12 babies from the 6th day after birth and in three babies who were six weeks old. The mean Sr : Ca ratio in the human milk received by the younger group of babies was $0.24 \pm 0.02 \times 10^{-3}$ and in the urine of the newborn $1.16 \pm 0.16 \times 10^{-3}$. For the babies six weeks old, this milk ratio was $0.26 \times 10^{-3}$ and that for urine $0.58 \times 10^{-3}$. The mean negative balance for Sr was −1.7 μg/kg day for babies between 6 and 8 days old, although the Ca balance was always positive. The 6-week-old babies were in positive balance for Sr as well as for Ca. Improvements in the assay of Sr, particularly in urine, are described and make the results more reliable. A neutron activation method was used which is more accurate for samples containing <5 μg Sr. An analysis of the results for the ratio Sr : Ca in the bone of infants born in the London area between 1957-60 and 1960-2 is presented. Higher levels were noted in the later samples. The results suggest that there is a slight fall in the ratio during the first few days after birth, followed by a rise in the ratio for infants more than eight

days old. It was shown earlier that bottle-fed babies were in positive balance for Sr as well as Ca, so that the ratio of Sr to Ca would be expected to increase for such infants. Thus the slight fall in the ratio found during the 1st week after birth might have been greater had all the babies been breast-fed. The Sr, Ca, and P contents of various tissues taken from stillborn babies were also measured. The Ca and Sr concentrations, as well as the ratio of Sr : Ca in bone, gut and contents, and soft tissue are given. It is suggested that the relatively high Sr : Ca ratios in soft tissues are due to relatively high concentrations of Sr in fetal blood compared with that in fetal bone. If renal discrimination against Sr is unchanged in the first 6 weeks after birth, the results indicate that excess Sr is being eliminated in the urine of the 6-to 8-day-old babies. Although a change in the output of Sr in the urine was detectable in breast-fed babies, it would not be measurable in bottle-fed infants for whom the daily intake of both Sr and Ca was several times greater. (TCO)

**31720** A STUDY OF THE STRONTIUM AND GLYCINE EXCHANGE IN EXPERIMENTAL DENTAL CARIES OF WISTAR RATS USING RADIOACTIVE ISOTOPES. Prochoncukov, A. A. Cesk. Stomatol., 64: 321-6(1964).

In an experiment on Wistar rats fed cariogenic sugar for 150 days, it was found that the exchange of $^{89}Sr$ and glycine-$^{14}C$ was disturbed at the precaries stage. The character and orientation of changes in the content of $^{89}Sr$ and glycine-$^{14}C$ were identical. However, in experimental dental caries the changes of $^{89}Sr$ exchange were substantially higher than the changes of glycine-$^{14}C$. The changes of $^{89}Sr$ and glycine-$^{14}C$ exchange in experimental dental caries occurred not only in teeth but in the skeleton as well. In different parts of the skeleton these changes had a different character and orientation. In molars there was an increased deposition of $^{89}Sr$ and glycine-$^{14}C$. In incisors, and in jaws and lumbar bones, the content of $^{89}Sr$ and glycine-$^{14}C$ was decreased. Changes in metabolism precede the development of the initial structural changes in the hard dental tissues. The depth of the disturbance in the exchange of $^{89}Sr$ and glycine-$^{14}C$ depended on the degree of dental caries. The progress of dental caries was in direct relation to the increase in the changes of metabolism. These were more pronounced in teeth than in bones. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965).

**31721** THE EFFECT OF THERMAL STRESS ON THYROID $^{131}I$ UPTAKE AT DIFFERENT LEVELS OF THYROID FUNCTION. Einhorn, J.; Tenner, J.; Oborska-Jadwiszczak, E. (Silesian Medical Academy, Gliwice, Poland). Endokrynol. Polska, 14: 619-26(Nov.-Dec. 1963). (In Polish)

The effects of hyperthemia on $^{131}I$ uptake by the thyroid were investigated in 11 euthyroid, 16 thyrotoxic, and six hypothyroid patients. In the first series of tests, 50 to 100-$\mu$C of $^{131}I$ was given one hour before inducing hyperthermia and in the second series thermal stress was induced simultaneously with $^{131}I$ administration. Each subject was examined twice: first for thyroid $^{131}I$ uptake without heating and then, after a two-week interval, for $^{131}I$ uptake with heating. In another group, sham-heating was arranged. This was carried out to obviate the effect of the emotional stress. Measurements were taken at 30-min intervals from the beginning of heating. The duration of the thermal stress was 1½ hr. One hour after the completion of heating and 24 hr after the administration of $^{131}I$, thyroidal activity was measured. In the first series $^{131}I$ accumulation by the hypofunctioning thyroid was essentially the same with or without heating. All epithyroidal counts were very low and the increase in radioiodine uptake was negligible. Also, in normal subjects thermal stress did not change radioiodine uptake in comparison with the test without heating. A marked increase in $^{131}I$ uptake was noted throughout the test in the group of subjects with thyrotoxicosis. In the second series of experiments no differences were observed in $^{131}I$ uptake between the heated and nonheated subject during the first hour after radioiodine administration. The observation that the rate of thyroid $^{131}I$ uptake is not affected by thermal stress shows that the observed increase in the basal metabolic rate in the thermal test was not due to increased thyroid function but rather to the direct effect of heating on tissue oxidation processes. It was concluded that the thermal test described does not affect the thyroid and as such does not measure its function. (TCO)

**31722** CONCENTRATION OF RADIOACTIVE IODINE IN FREE TRANSPLANTS OF THYROID GLANDS. Ojima, Shozo (Tottori Univ., Yonago, Japan). Endokrinologie, 44: 312-25(Aug. 1963). (In German)

Portions of the thyroid from a male rabbit were transplanted to liver, lung, mesenteric lymph glands, and the subcutis. Twenty weeks later 40 $\mu$C of $^{131}I$ was given subcutaneously. Its concentrations in the transplanted tissue after 24 hr were studied autoradiographically. Many of the animals with lung transplants died postoperatively. The liver transplants became functional after 2 or 3 weeks. Regeneration of follicles was slight at the periphery of the transplant. The follicles were frequently polymorphic, with cubical epithelia. The autoradiographic and histological structures differed somewhat. The larger follicles sometimes contained more radioactivity than the smaller polymorphic follicles. The transplants in the lymphatic areas became functional in 1 or 2 weeks. Uptake of $^{131}I$ in the adjacent lymphatic tissues also was observed. The subcutaneous transplants started to regenerate morphologically and functionally within 1 week, but 2 or 3 weeks were required for complete regeneration. The degree of regeneration measured autoradiographically was compared to normal tissue. Regeneration capability of the transplants was 20% after 6 weeks, 70% after 20 weeks, 40% after 3 weeks, and 70% after 6 weeks for the liver, lung, lymphatic, and subcutaneous transplantation sites, respectively. The transportability of $^{131}I$ from lymphatic sites to other portions of the lymphatic system was studied. There was greater diffusion of subcutaneously transplanted thyroid tissue to lymphatic tissue if the transplant was located distally in relation to the lymphatic tissue. (BBB)

**31723** DETECTION OF SMALL AMOUNTS OF RADIOACTIVE MATERIALS IN CEREALS AND CEREAL PRODUCTS. Merten, H. Getreide Mehl, 13: 136-9 (1963).

The general principles of this determination are briefly outlined, and the results obtained for 12 nuclides in grain having a total radioactive contamination of $10^{-11}$ Curie per kg are tabulated. (Anal. Abstr., 12: (March 1965))

**31724** EFFECTS OF DRUGS ON RADIOACTIVE IODINE UPTAKE BY THYROID IN RATS. Gaitonde, B. B.; Satoskar, R. S.; Dadkar, N. K. (Grant Medical Coll., Bombay). Indian J. Physiol. Pharmacol., 7: 252-8(Oct. 1963).

The effect of phenylbutazone, sulfadimethoxine, reserpine, and nialamide on thyroid $^{131}I$ uptake at four hr in rats was studied. In control animals the mean uptake of $^{131}I$ per 10 mg of thyroid at 4 hr was 11.24%. When 20 mg/kg of phenylbutazone was given intramuscularly one hr prior to administration of radioiodine, the uptake was 14.2% per 10 mg of thyroid. This difference in uptake was statistically significant. When the same dose of phenylbutazone was administered for seven days, there was a marked inhibition of thyroid $^{131}I$ uptake; the uptake was 3.4%, the difference being highly significant when compared with previous group receiving a single injection of phenylbutazone. A dose of 50 mg/kg of phenylbutazone intraperitoneally given one hr prior to administration of $^{131}I$ caused a similar reduction of uptake by thyroid as phenylbutazone given for seven days. After addition of prednisolone, at a dose of 1.25 mg/kg, the average was 3.1%, showing that prednisolone does not affect this action of phenylbutazone. Rats were also treated with sulfadimethoxine in a dose of 25 mg/kg. This drug produced a marked inhibition of $^{131}I$ uptake (to 5.0%). Since tranquilizers are often prescribed in thyroid disorders, effects of reserpine and the monoamineoxidase inhibitor nialamide

were also studied. A dose of 5 mg/kg of reserpine was administered 24 hr prior to administration of radioiodine. The average uptake (10.4%) was lowered significantly. Nialamide was administered in a dose of 25 mg/kg one hr prior to administration of $^{131}I$. The mean uptake in this group was 19.0%, which difference was not significant with respect to controls. Sulfonamides are known to produce a goitrogenic effect, and many long acting sulfonamides have been introduced into therapy. It is therefore of interest to note that single dose of 25 mg/kg of dimethoxine given parenterally caused a marked inhibition of thyroid activity in a period of 5 hrs. Prolonged treatment with long-acting sulfonamides may thus cause a deleterious action on thyroid. Tranquilizers are often used in hyperthyroid states. Reserpine in the dose used is known to cause a marked depletion of catecholamine and 5-hydroxytryptamine content of the brain. The lowering of iodine uptake could therefore be due to central action of reserpine. However, an action of reserpine directly on the thyroid cannot be excluded. (BBB)

**31725** ELECTRON MICROSCOPIC OBSERVATIONS ON THE ACCUMULATION OF DIVALENT CATIONS IN INTRAMITOCHONDRIAL GRANULES. Peachey, Lee D. (Columbia Univ., New York). J. Cell Biol., 20: 95-111 (1964).

Electron microscopic evidence is presented, from mitochondria in whole cells of toad urinary bladder and from isolated rat kidney mitochondria, indicating that the divalent cations Ca, Sr, and Ba are accumulated in granules localized in the mitochondrial matrix. This accumulation occurs under conditions in which divalent ions are present in the medium bathing either whole cells or isolated mitochondria. Both the epithelial and smooth muscle cells of urinary bladders incubated with 2 mM Sr or Ba acetate in Ringer's solution showed unusually dense granules in their mitochondria. Mitochondria in these preparations otherwise had a sufficiently normal fine structure to be easily identifiable. The dense granules were found in the mitochondrial matrix, between the cristae, the same location of the usual intramitochondrial granules. In many granules the dense material formed a shell around a less dense core. At high magnification the granules were seen to consist of finer granules about 40 Å in dia. The dense intramitochondrial granules in cells incubated with Sr or Ba were usually between 200 and 800 Å in dia. They tended to be larger and more numerous in epithelial cells following treatment with antidiuretic hormone. Incubation of isolated mitochondria with Sr or Ba caused an obvious increase in the density of the intramitochondrial granules. The size of these granules is about double (400 Å) that of the granules in the unincubated preparations. There was slight structural damage to mitochondria incubated in Sr, and the damage in Ba, although greater than in Sr, was considerably less than in Ca-containing media. Whether the observed changes in density of the intramitochondrial granules can be attributed to an accumulation of divalent cations is discussed. Since the only difference between experiments in which granules of different density were observed was the divalent cation present in the incubation medium, the divalent cations must be considered at least the indirect cause, if not the direct cause, of the observed densities. Furthermore, the denser granules were observed when the heavier the divalent cations (Sr, Ba) were present in the medium. This would be expected if it were the divalent cations themselves which accounted for the increased density, since electron-scattering power, and thus density in electron micrographs increases with at. no. of 56 and 38, respectively, would be very apparent against a background of organic cellular and embedding material. It is concluded that the observed increases in density of the intramitochondrial granules after incubation with Ba, Sr, and Ca are due to accumulation of these elements. A hollow appearance of the granules was especially prominent in cells incubated in Sr or Ba, in which the contrast was highest, but was observed also in cells incubated in high Ca concentrations. This finding suggests either that the incubation resulted in the formation of granules with surface-localized binding sites or, more probably, that the denser cations are deposited selectively on the surfaces of pre-existing granules, possibly in exchange for other cations. (BBB)

**31726** THE EFFECT OF ACUTE IODIDE DEPLETION ON THYROID FUNCTION IN MAN. **Barakat, Russell M; Ingbar, Sidney H. (Boston City Hospital and Harvard Medical School, Boston). J. Clin. Invest., 44: 1117-24 (July 1965).**

Acute depletion of extracellular iodide was achieved in eight patients, including two with diffuse toxic goiter, by institution of a low-iodine diet, followed 24 hours later by an infusion of mannitol to increase renal clearance of iodide. Measurements of plasma iodide ($^{127}I$) concentration, thyroid $^{131}I$ transfer and clearance rates, renal $^{131}I$ clearance rate, absolute iodine ($^{127}I$) accumulation rate, and serum protein-bound iodine were made before, during (four patients), and 24 hours after mannitol infusion. This iodide depletion procedure resulted in decreased plasma iodide concentration, increased thyroid transfer and clearance rates, increased uptake of $^{131}I$, and decreased absolute iodine accumulation. These changes, which were usually evident during the mannitol infusion, were uniformly present by the following day. Serum protein-bound iodines varied only slightly from control values. Decreases in plasma iodide concentration were prevented by inclusion of only 800 μg of sodium iodide in the mannitol infusion, and, under these conditions, the increase in $^{131}I$ clearance and uptake did not occur. It is concluded that there exists a mechanism for acutely increasing thyroid function in response to a relatively abrupt decrease in plasma iodide concentration. This mechanism apparently is not mediated by the pituitary, but resides within the thyroid gland itself. (auth)

**31727** AN ACCURATE ISOTOPE DILUTION METHOD FOR MEASURING PLASMA FIBRINOGEN. **Atencio, A. C.; Burdick, D. C.; Reeve, E. B. (Univ. of Colorado, Denver). J. Lab. Clin. Med., 66: 137-45(July 1965).**

Current methods of measuring plasma fibrinogen require its separation by coagulation or precipitation. To avoid errors from incomplete separation and from occlusion of other proteins in the separated protein, an isotope dilution method was developed in which $^{131}I$-fibrinogen is added to plasma, the plasma fibrinogen is partially purified and coagulated with thrombin, and the radioactivity and fibrin in the washed coagulum are determined. The fibrin weight is obtained from its ultraviolet absorption after solution in alkaline urea. Methods of preparing nearly pure fibrinogen and labeling it with $^{131}I$ are described. The isotope dilution method has a coefficient of variation of 3.8 per cent and, as tested by recovery experiments, performs satisfactorily. Iodine-131-labeled fibrinogen of the same species as the plasma is required. A mean value of 3.72 ± 1.10 mg. per milliliter was found in 18 healthy subjects in Denver. (auth)

**31728** DETERMINATION OF THE MERCURY CONTENT OF HUMAN BLOOD BY ACTIVATION ANALYSIS. **Kellershohn, C.; Comar, D., Le Poec, C. (Commissariat a l'Energie Atomique, Orsay, France and Service Hospitalier Frederic Joliot, Orsay, France). J. Lab., Clin. Med., 66: 168-76(July 1965).**

A quantity of mercury as small as $10^{-3}$ μg may be measured with an accuracy of ±5 per cent by activation analysis. Mercury was found in the blood of the 14 normal human subjects studied (5 adults and 9 children, the majority female). In 10 of these subjects, the mercury content was measured in plasma, red cells, and total blood. The mercury content did not vary significantly with age or with the presence of dental amalgam, but the group is too small for the results to be conclusive. The blood of normal subjects contained 1,000 times more zinc than mercury. (auth)

**31729** A RADIOAUTOGRAPHIC STUDY OF THE TRANSFER OF $^{32}P$-LABELED T2 PARENTAL DNA TO PROGENY PHAGES. Kahn, Phyllis L. (Yale Univ., New Haven). J. Mol. Biol., 8: 392-404(Mar. 1964).

There is disagreement about the way in which the transferred $^{32}P$ appears in the progeny phage, i.e. it has not been clear whether the $^{32}P$ is distributed to a few of the progeny in fairly large aggregates or appears in many of the progeny in very small pieces. In view of the conflicting results reported, experiments were conducted to re-examine $^{32}P$ transfer, using the radioautographic method with modifications to reduce the possibility of producing a spurious result due to radiation damage from the $^{32}P$. The effect of radiation damage on the transfer was also assessed. Distribution of parental $^{32}P$-labeled DNA to progeny T2 phages was studied by a radioautographic method involving counting the $^{32}P$ received by individual progeny. A method, taking about one hr, of phage purification by adsorption onto and elution from a column was used instead of a more time-consuming differential contrifugation process, to attempt to eliminate high radiation damage as a possible source of artifact. The results found, upon observation of the progeny phage emulsions for the presence of large pieces of parental DNA, did not agree with those reported earlier, showing a more heterogeneous population with a greater disposition to pieces smaller than the 20% piece originally found. From control emulsions of the parental phages, this deviation could not be explained by inefficiency of detection by the emulsions. As would be expected from the heterogeneous distribution, the number of progeny phages containing detectable amounts of parental DNA increases with exposure time. From counting the total number of $\beta$-ray tracks in the final distributions obtained, it was seen that about 60 to 80% of the transferred radioactivity appears in the progeny in pieces of less than 4 to 5% of the total parental DNA. An experiment to investigate the effect of an increase in radiation damage by a factor of two to the same parental population prior to infection and transfer showed no significant difference in the two progeny populations obtained. (BBB)

**31730** COMPARISON OF THE SENSITIVITY OF NORMAL HEMATOPOIETIC AND TRANSPLANTED LYMPHOMA COLONY-FORMING CELLS TO TRITIATED THYMIDINE. Bruce, W. R.; Meeker, B. E. (Ontario Cancer Inst., Toronto). J. Natl. Cancer Inst., 34: 849-56(June 1965).

Dose-survival curves were obtained for normal hematopoietic and transplanted lymphoma colony-forming cells of mice to high specific activity tritiated thymidine administered by repeated intraperitoneal injections for 24 hours. While the curve for normal cells decreased to a plateau value of about 20% of normal value at the maximum dose studied (6 mC/mouse), the curve for lymphoma cells decreased to a value less than 0.1% at this dose. An experiment in which the responses of normal and lymphoma colony-forming cells were measured in the same host showed that this difference was not due to differences between normal and lymphoma-bearing hosts. Furthermore, the survival time of mice bearing transplanted lymphoma was significantly increased (from 6.5 to 13 days) if they were given injections of 6 mC of tritiated thymidine over a period of 24 hours. The results indicate that most normal cells do not pass through deoxyribonucleic acid synthesis in 24 hours, but that most lymphoma cells do and consequently may incorporate tritiated thymidine and be killed during this period. The difference between the cycle of normal hematopoietic colony-forming cells and malignant colony-forming cells may explain the action of chemotherapeutic agents that kill cells passing through cycle. (auth)

**31731** PHARMACOLOGY AND TOXICOLOGY OF EUROPIUM CHLORIDE. Haley, Thomas J.; Komesu, N.; Koste, L.; Upham, H. C. (Univ. of California, Los Angeles). J. Pharm. Sci., 54: 643-5(Apr. 1965). (UCLA-12-537)

The oral and intraperitoneal $LD_{50}$ of Eu was obtained with male CF1 mice, and chronic toxic effects of the element were studied by including 0.01, 0.1, and 1.0% of Eu in the diet and feeding it as the chloride over a period of 12 weeks to CRW rats. Observations of total erythrocytes, total leukocytes, differential cell count, platelets, hemoglobin, hematocrit, and body weight were made, as well as histopathological examination of the heart, lung, liver, kidney, spleen, pancreas, adrenal, and small intestine. Symptoms of acute toxicity from $EuCl_3$ were arched back, writhing, ataxia, lachrymation, stretching of the hind limbs, and depressed respiration. The acute intraperitoneal $LD_{50}$ was 550 mg/kg and the acute oral $LD_{50}$ 5000 mg/kg. Feeding $EuCl_3$ had no effect on growth, total erythrocyte count, total leukocyte count, differential cell count, thrombocyte count, hemoglobin, or hematocrit values. At autopsy, all organs appeared normal and histopathological examination showed no changes attributed to ingestion of Eu for 12 weeks. No detectable damage to the cornea or the iris was observed after application of 0.1 ml of a 1:1 concentration of $EuCl_3$ to the eye, but one hour after the application the rabbit's conjunctival membranes were red, the eyelids were almost completely closed, and a discharge moistened the lids and hairs about the eye. This high degree of irritation persisted for 7 days, and conjunctival ulcers were observed also. No detectable pharmacodynamic effects were observed in the cat with doses of 1 to 10 mg/kg of $EuCl_3$. At 20 mg/kg there was a transient hypotension but no effect on heart rate or femoral blood flow. This dose was fatal to two animals though, death resulting from cardiovascular collapse coupled with respiratory paralysis. (TCO)

**31732** ASSESSMENT OF THE INCORPORATION OF RADIUM BY MEASUREMENT OF THE RADON IN THE EXPIRED AIR. Toth, A. (Uranegeszsegugyi Szolgalat, Pecs, Hungary). Kiserl. Orvostud., 16: 428-38(1964).

A simple method is described for determining radon in the expired air. The analytical sources of error are discussed. The results of studies on radon uptake and release by healthy subjects and patients with silicosis are reported. With reference to these results the interfering effect of the ambient radon was estimated. The studies were done with saturation radon concentrations of some 1 picocurie/litre. Assessment of the half-saturation time agreed with the findings by other authors. Some problems of technique and evaluation are discussed, and the advantages, disadvantages and sensitivity of the method analyzed. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31733** EFFECTS OF ALDOSTERONE ON $^{134}Cs$ EXCRETION AND ON ITS ACCUMULATION IN RAT MUSCLE. Simon, Gyorgy; Gati, Tibor; Vagfalvy, Ilona; Bach, Imre (Orvostudomanyi Egyetem, Korelettani Intezet, Budapest). Kiserl. Orvostud., 16: 80-2(Jan. 1964). (In Hungarian)

Tests were conducted to determine the effects of aldosterone on $^{134}Cs$ excretion as influenced by normal and potassium-deficient diets. Rats were divided into three groups plus control groups; one group received a normal diet for three days supplemented by 15 mg daily dose of inactive CsCl, then 250 $\mu$g of aldosterone was administered together with 4 $\mu$C of carrier-free $^{134}CsCl$/100 g body wt intraperitoneally. Urine was collected for 3 hr and assayed. The second group was treated the same as the first, but 48 hr after the first $^{134}Cs$ injection the dose was repeated and 250 $\mu$g aldosterone was also administered. Urine was collected for 24 hr; its radioactivity and that of the gastrocnemius muscle was measured. The diet of the third group contained 1/3 as much K as normal, the rest of the treatment was the same as that of the second group. In the first group there was no difference in the figures obtained between the treated and untreated animals; the figures were 909 cpm/ml as compared to 741 cpm/ml of those treated with aldosterone. The figures for the other two series were as follows: 24-hr urine volume collected for the control group on normal diet was 2.57 ml, for the normal diet group treated with 250 $\mu$g aldosterone, 2.85; for the K-deficient diet not given the hormone, 2.5 ml; aldosterone + K-deficient diet, 3.7 ml; urine radioactivity in cpm/ml was 1048, 866, 704, 524 respectively; cpm/24 hr urine, 2115, 2458, 2168, 1943; cpm/

24 hr urine in % of control value, 100, 116, 100, 90; cpm/g muscle, 49.2, 59.6, 162, 183; cpm/g muscle in % of control value, 100, 121, 100, 113. It was expected initially that aldosterone would increase the $^{134}Cs$ excretion in the urine and lower its muscle level. This was not demonstrated in either the normally fed or K-deficient diet animals. However, a trend was noted in the aldosterone-treated animals of lowered excretion and accumulation of Cs in the muscle. This indicates that although in biological materials Cs behaves similarly to K, it does not do so in all respects. The $^{134}Cs$ activity of the muscle in K-deficient animals was three times higher than normal. (BBB)

**31734** STUDY OF THE ADRENO-THYROID SYSTEM USING DOUBLE $^{131}I$ AND $^{32}P$ LABELING. Banos, Csaba; Nagy, Janos (Orvostudomanyi Egyetem Orvosi Fizikai Intezete, Budapest). Kiserl. Orvostud., 16: 136-42(Apr. 1964). (In Hungarian)

Attempts were made to perfect a procedure by which the interrelated functions of the thyroid and the adrenal gland and their functional changes can be demonstrated in the same animal, and at the same time the uptake of $^{131}I$ and $^{32}P$ by the thyroid be observed to indicate its function and the secretion of endogenous thyrotropin (TSH). Experiments were conducted on rats which were given 0.1 $\mu$C carrier-free $^{131}I$ and 100 $\mu$C carrier-free $^{32}P$ intraperitoneally. The iodine was administered 24 hr prior to removal of the thyroid, and the $^{32}P$ one hr prior to that time. The thyroid glands were appropriately prepared for measurement of the $\gamma$ activity of the $^{131}I$ by a scintillating device and the $\beta$ activity of the $^{32}P$ by a GM counter. The softer $\beta$ component of $^{131}I$ was filtered out by a 0.72-mm Al foil. Data indicated that the isotope uptake of the thyroid depends on the season. In experiments in Oct. and Nov., thyroid gland wt was 8.3 mg/100 g body wt, $^{131}I$ uptake 22.0%, $^{32}P$ absorption 0.0116%; in experiments conducted in Dec. and Jan. the values were 10.2, 38.0, 0.019; Feb. 10.5, 48.6, 0.0254; Mar. 10.8, 43.2, 0.0259. Methothyrin and p-hydroxypropiophenone (PHP) were administered to some animals three to six days prior to sacrifice. Those treated in Oct. and Nov. with 5 mg Methothyrin for seven days showed a thyroid wt of 9.2 mg/100 g body wt, $^{131}I$ uptake of 45.9%, and $^{32}P$ uptake of 0.0221%; the Mar. figures were for 1 × 10 mg Methothyrin 12.0, 58.2, 0.0316; in Feb. with PHP 0.2 g orally for 14 days, 7.8, 31.2, 0.0133. In another series of experiments 10 mg Methothyrin was given in one dose to a number of animals and they were sacrificed on succeeding days. Uptake of both isotopes rose above the control levels on the third day indicating an increased TSH excretion. Uptake of $^{32}P$ dropped below control levels after the 6th day showing inhibition of TSH secretion due to hyperfunction of the thyroid. Figures are also furnished on isotope uptake when animals were receiving a daily dose of 5 mg Methothyrin, daily doses of 2.5 mg NaI following a 14-day Methothyrin treatment, and on isotope uptake during and after continuous Methothyrin treatment. It is concluded that, aside from variations due to seasons, medication, etc., $^{131}I$ incorporation changes similarly to $^{32}P$ incorporation. Continuous Methothyrin treatment resulted in groups having a higher $^{131}I$ and $^{32}P$ control values reaching the initial $^{32}P$ absorption max earlier and at lower level. In these experiments the $^{32}P$ %-uptake values do not follow the drop in thyroid wt after having reached the max, but keep increasing or approach a saturation point. (BBB)

**31735** PREFERENTIAL BLOCK OF STRONTIUM ACCUMULATION IN TETRAHYMENA PYRIFORMIS BY SULFADIAZINE. Ballentine, Robert; Burford, Dorothy D. (Johns Hopkins Univ., Baltimore. McCollum-Pratt Inst.). Life Sci., 3: 1455-8(1964). (TID-21029)

The effects of specific nutritional deficiencies and of metabolic inhibitors on calcium and strontium metabolism using Tetrahymena pyriformis, strain W, as the test organism were studied. It was found that this organism is capable of accumulating both calcium and strontium reaching an intracellular concentration as much as 1000 times greater than that in the external environment. This only occurred in cell populations actively growing and multiplying not in a resting cell suspension. The effects of dinitrophenol, dicoumarol, thiouracil, pyridine-3-sulfonate, benzimidazole, eserine, and sulfadiazine were determined. Sulfadiazine provided a striking alteration in the calcium and strontium metabolic pattern. Even at concentrations which were without effect on the growth rate and which only moderately depressed calcium accumulation, complete inhibition of strontium uptake was observed after several cell generations. (M.C.G.)

**31736** EXISTENCE OF NON-EXCHANGEABLE CALCIUM COMPARTMENTS IN PLASMA. Giese, W.; Comar, C. L. (Cornell Univ., Ithaca, N. Y.). Nature, 202: 31-3(Apr. 4, 1964).

To demonstrate a nonexchangeable component of plasma Ca, experiments were conducted in sheep and rats using $^{45}Ca$, $^{85}Sr$, and $^{89}Sr$. The experiments were based on the assumption that a difference between specific activity of plasma and urine following administration of $^{45}Ca$ would demonstrate the existence of Ca compartments, presumably in the plasma, between which Ca ions were not exchangeable. The time-course of plasma and urinary specific activities was established with sheep. A supporting experiment with rats using two Sr radionuclides completely avoided any possible error from chemical determinations. The data from the sheep injected with $^{45}Ca$ show that the specific activity of plasma and urine was about the same in the normal animal; however, in the starved animal the specific activity for the urine was markedly lower than that of the plasma. Examination of the effects of starvation on the levels of Ca and $^{45}Ca$ in plasma and urine showed that starvation caused a consistent drop in the plasma Ca by a factor of 0.7–0.9. The amount of circulating $^{45}Ca$ considerably increased by starvation. The data for the rat study based on the simultaneous use of two Sr radionuclides showed that in the normal animals the ratios of $^{89}Sr/^{85}Sr$ in the blood and urine were about the same, whereas in the starved animals the ratio of $^{89}Sr/^{85}Sr$ in the urine tended to be lower than the value in the blood. Thus, different specific activities of Ca between blood and urine can occur and these observations are not the result of technical uncertainties. The observations therefore imply that in the plasma of the starving animal there must be at least two forms of Ca between which the added radiocalcium is not exchangeable; furthermore, one form is more readily excreted into the urine than is the other. (TCO)

**31737** EFFECT OF ALGINIC ACID ON THE MOVEMENT OF STRONTIUM-85 AND CALCIUM-45 ACROSS SURVIVING ILEAL SEGMENTS. Moore, W., Jr.; Elder, R. L. (Public Health Service, Montgomery, Ala.), Nature, 206: 841-2(May 22, 1965).

Studies were made on the effects of alginic acid on the movement of $^{85}Sr$ and $^{45}Ca$ across ileal segments from rats. Five different concentrations of alginic acid were used. The results indicated that there was differential absorption of $^{45}Ca$ and $^{85}Sr$ and that $^{45}Ca$ was favored over $^{85}Sr$, but this phenomenon was not temperature dependent. However, with increasing concentration of alginic acid, there was a reduction in the difference in the amount of Ca and Sr held by the alginic acid due to the increased number of sites available for reaction with a constant amount of Ca and Sr. It was concluded that the differential retention of Ca and Sr by alginic acid is probably due to the slightly more reactive nature of Sr in competing for available sites. (P.C.H.)

**31738** BIOLOGICAL STABILITY OF 5-IODO-2'-DEOXYURIDINE LABELLED WITH IODINE-125 AFTER ITS INCORPORATION INTO THE DEOXYRIBONUCLEIC ACID OF THE MOUSE. Commerford, S. L. (Brookhaven National Lab., Upton, N. Y.). Nature, 206: 949-50(May 29, 1965). (BNL-8714)

The distribution of $^{125}I$ activity was determined in a litter

of eight mice whose mother was given $^{125}$I-labeled 5-iodo-2'-deoxyuridine (IDU) three days before giving birth. Retention of the isotope was assessed in skin, small intestine, liver, kidneys, lungs, in addition to whole-body measurements. When $^{125}$IDU was given to mice less than one week-old, an appreciable amount of label was retained for over a year. The label retained represented $^{125}$IDU incorporated into DNA. Rate of turnover was very small and was accountable by cell death, assuming that DNA is metabolically inert and is lost only when the cell containing it dies. (H.G.D.)

**31739** TRANSLOCATION OF PHOSPHORUS-32 IN RHIZOCTONIA SOLANI. Littlefield, L. J.; Wilcoxson, R. D.; Sudia, T. W. (Univ. of Minnesota, St. Paul). Phytopathology, 55: 536-42(May 1965).

The radioisotope technique described provides a method for the quantitative study of translocation in mycelium. Injection of the $^{32}$P into the agar block in which the fungus was growing helped localize the area in which the isotope was absorbed. Experiments made in which the isotope was applied directly to the mycelium growing over the surface of a microscope slide indicated that some of the isotope moved along the hyphalsurfaces by means of capillarity. Adsorption of the isotope into the agar block apparently prevented such movement. Isolation of the sampling locations prevented contamination by $^{32}$P that had diffused from the mycelium. The results of the various experiments demonstrated that translocation in R. solani is a complex metabolic process. Significantly more of the isotope was translocated by the fungus at 20, 25, and 30°C than at 4, 10, 15, or 40°C. More of the isotope was moved through the medium by the fungus than by diffusion and some isolates of the fungus translocated more $^{32}$P in a given time than did others. When the isotope was placed on old portions of colonies, less was absorbed and translocated to various portions of the colonies than when the isotope was placed on young portions of colonies. The fungus tended to direct the movement of $^{32}$P toward sclerotia, and there was a marked accumulation of the isotope in sclerotia, hyphal tips, and at the branches of hyphae. Light had no apparent effect upon $^{32}$P transport in R. solani. Despite the evidence that the process is metabolic, the actual mechanism of P translocation in R. solani is not known. (BBB)

**31740** MOVEMENT OF TRITIATED WATER IN THE ROOT SYSTEM OF HELIANTHUS ANNUUS IN THE PRESENCE AND ABSENCE OF TRANSPIRATION. Raney, Franklin; Vaadia, Yoash (Inst. of Arid Zone Research, Beersheva, Israel). Plant Physiol., 40: 378-82(Mar. 1965).

Movement of tritiated water was followed in 2- to 2-week-old root systems of Helianthus plants grown in nutrient solution containing tritiated water (THO) at 20°C. Sunflower plants grown 2 weeks in nutrient solution containing only $H_2O$ were detopped at the cotyledonary node, and the root system was submerged in a large volume of THO. At various times, root systems were removed from the solution, blotted, and analyzed for tritium. The THO content of the tissue water from sunflower roots detached from the shoot before treatment tended toward equality with the external solution with a half-time of 30 sec and closely approached the external value after about 1.5 hr. Thirty-day-old sunflower plants were used to investigate the effect of transpiration upon equilibrium half-times and the pattern of tritium distribution in the root. Some of the intact plants were exposed to light and others were kept in the dark during submergence of the root system in tritiated nutrient solution. At intervals, root systems were analyzed for THO. Various parts of a detached root system approached external tritium concentration at differing rates. The max rate of gain of tritium activity over shorter intervals occurred in the middle sections of the root system of sunflower. At first, the tips of the root system and the root segments near the water surface gained radioactivity the most slowly. After about 30 min, the apical third of the root systems was gaining activity at the same rate as the middle third. The upper third of the root system, near the surface of the solution, was still lagging. Root systems of shoots held in darkness acquired tritium from the external solution with a similar pattern to that of detached root systems. Strikingly different results were obtained when the influx of tritium was determined while the root systems of intact plants were exposed to THO during a light period of 12 hr. During the first 2 hr the root system approached equality with tritium in the external solution much more slowly when the shoot was transpiring than when the root was detached from the shoot or when the intact plant was in the dark. Again, the root tips and the root zone near the surface of the solution lagged far behind for the first 2 hr. (BBB)

**31741** MOVEMENT AND DISTRIBUTION OF THO IN TISSUE WATER AND VAPOR TRANSPIRED BY SHOOTS OF HELIANTHUS AND NICOTIANA. Raney, Franklin; Vaadia, Yoash (Inst. of Arid Zone Research, Beersheva, Israel). Plant Physiol., 40: 383-8(Mar. 1965).

The pattern of movement and distribution of THO in sunflower and tobacco was studied by measuring influx and efflux of tritium in stems and leaves of intact plants and transpired vapor in both open and closed systems. In sunflower plants exposed to light with roots in tritiated water, during a 12-hr light period, concentrations of tritium in the stem tissue and petioles of mature leaves approached equality with the concentration of tritium in the nutrient solution. The approach to equality was much slower in the terminal several nodes and the internodes that were still elongating and in leaf tissue that was still expanding. The apical two nodes and internodes, bracts, inflorescence parts, and seeds did not reach equality even when the plants had been grown from seed to seed maturity in tritiated water. The tritium concentration in the leaves of intact plants growing in tritiated water did not reach the concentration of the external medium over a protracted period. Although the veins themselves equilibrated in a manner similar to that of the mature stem and petiole, the interveinal tissue did not reach tritium equality with major veins, the stem, or the external solution. Water of the interveinal tissue maintained a stable tritium content at 60 to 70% of external concentration for long periods. The pattern of results obtained was similar in tobacco, and followed that described above for sunflower. Tritium content of leaf-tissue water vapor transpired by the canopy of an intact sunflower plant raised from seed in THO and treated with a steam of dry air inside a closed chamber increased over a 12-hr period. At the end of this period, interveinal tissue water and transpired vapor reached at least 95% of the external tritium concentration about the roots. Lack of equilibration in interveinal tissue could be attributed to exchange of tritium between the leaf and the surrounding unlabeled water vapor of the atmosphere. These results contradict the hypothetical concept that a sizable fraction of tissue water is inaccessible for turnover. (BBB)

**31742** MOVEMENT OF CALCIUM IN BOTH DIRECTIONS ACROSS THE PRIMATE PLACENTA. MacDonald, Norman S.; Hutchinson, Donald L.; Hepler, Marilyn; Flynn, Elizabeth (Univ. of California, Los Angeles). Proc. Soc. Exptl. Biol. Med., 119: 476-81(June 1965).

Transfer of Ca from mother to fetus concurrent with transfer from fetus to mother was studied in three pregnant Rhesus monkeys. Calcium-45 was injected into a fetal interplacental vessel simultaneously with intravenous injection of $^{47}$Ca into the anesthetized mother. Samples of maternal blood (MB), fetal blood (FB), and amniotic fluid (AF) were assayed for $^{45}$Ca, $^{47}$Ca and non-radioactive Ca. Initial loss of $^{47}$Ca from MB was matched by rapid initial appearance in FB ($t_{\frac{1}{2}} < 6$ min) and somewhat slower entry into AF. Similarly, $^{45}$Ca appeared in MB at a rate almost equal to the initial rate of loss from FB. The quantity of Ca crossing the placenta daily was at least 6 to 10 times that required for fetal skeletal growth. (auth)

**31743** MECHANICAL RESISTANCE OF ERYTHROCYTES FOLLOWING X-IRRADIATION IN VITRO. Mor-

czek, A.; Otto, H.-J. (Strahlentherapeutische Klinik, Medizinische Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 6: 229-36(1965). (In German)

Changes of fragility of erythrocytes by x rays were demonstrated by means of osmotic test for resistance and by means of determining the survival time of irradiated red blood cells in organism. With equipment that was developed, a test was elaborated that permits the investigation of mechanical resistance under different conditions of x irradiation in vitro. In a dose range between 10 and 40 kR the hemolytic effect in dependence on the dose is increased. The mechanism of radiation hemolysis and its importance are discussed. (tr-auth)

**31744** THE ANALYSIS OF MYCOBACTERIAL PHOSPHATIDES AND LABELING OF MYCOBACTERIA BY PULSATION. Pokorny, J. Rozhledy Tuberk., 24: 593-600 (1964).

Two questions were investigated at the Tuberculosis Research Institute in Prague by the isotope technique: firstly the problem of internal structure of mycobacterial phosphatides, secondly a new technique for labeling live mycobacteria by so-called pulsation was studied. Mycobacterial phosphatides were labeled with the isotope $^{32}P$ using the cultivation technique of incorporation in a surface culture growing on Sauton medium. Bacteria were afterwards extracted in a Soxhlet apparatus with ethanol-ether. Phosphatides proper were isolated from neutral fats by precipitation in acetone and were separated by adsorption column chromatography on $Al_2O_3$ in a system of organic solvents of rising polarity (benzene, petrol-ether, ether, acid ether, methanol, water). Evidence is presented on the successful separation of the lipid portion of the phosphatide molecule, of free and esterized higher fatty acids from polar glycerophosphates, and to show that bonds between these lipids and phosphates are extremely lax and unstable. Hydrolytic measures are not required, mutual separation of both parts of the molecule may be accomplished by filtration through substances with surface activity, such as cellulose, carbon. Pulsation as a technique for isotope incorporation has the advantage that the mycobacterial cultures are exposed during a certain evolutive phase to the radioactive compound. Suitable conditions were devised for labeling 14 to 21 day old cultures of Mycobacterium tuberculosis with $^{14}C$ (0.5 mC $Na_2C^{14}O_3$, 48 hours, 37°C, shaking, phosp. buffer). Relatively high activity was found in the alkaline total hydrolysate (more than 150 imp/0.1 ml). Qualitative separation of higher fatty acids by proper chromatography revealed that $^{14}C$ had become chiefly incorporated in the highest acids starting from $C_{88}$-mycolic to $C_{20}$-arachic. These are mainly higher fatty acids participating in the build-up of lipid compounds located on the surface of mycobacterial cellular walls. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31745** INCORPORATION OF RADIONUCLIDES INTO MYCOBACTERIA. Kuska, J.; Trnka, L.; Urbancik, R. Rozhledy Tuberk., 24: 601-8(1964).

The exchange of phosphates and sulfates between the external environment and the mycobacterial cell was studied. The radioisotopic method was selected as providing an opportunity for observing the kinetics of metabolic processes dependent on time. The effect of the external environment (composition of the medium) was studied, as well as the effect of various cultural conditions (amount of medium and specific activity of the studied substance in the medium, the age of various mycobacterial strains) on the rate and intensity of interchange reactions. Changes in the contents of magnesium sulfate in the liquid medium not accomplished by changes of phosphate contents had no substantial effect on the degree of phosphorus utilization, growth or dehydrogenase activity. The contents of phosphates had a direct effect on the growth rate of mycobacteria. Omission of the phosphate buffer had a distinct inhibitory effect on mycobacterial growth. Incorporation of radioactive phosphorus was directly dependent on the specific activity of the growth medium. Metabolically active cells are required for the utilization of phosphorus from the external environment, the specific activity of incorporated phosporus and dehydrogenases activity was independent of the amount of medium used for cultivation of mycobacteria. The age of the culture used was indirectly correlated to growth and dehydrogenase activity, as well as to phosphorus utilization. Comparison of phosphorus utilization by various BCG substrains revealed some differences. No statistical significance was established. Serial studies of phosphorus incorporation are not suitable as tests for the standardization of BCG. Increased specific activity of sulphur in Sauton medium resulted in an increased specific activity of mycobacteria cultivated, and vice versa, regardless of whether this increased activity was due to a reduced content of inactive sulphur, or whether it was attained by an increased concentration of radioactive isotope in the medium. The stability of radioactive sulphur was higher in comparison with radioactive phosphorus. Comparison with incorporation of $^{131}I$ revealed a difference in principle regarding incorporation between metabolites and non-metabolites of mycobacteria, adsorption on the cellular surface, or linkage to some components of damaged cells are mainly concerned in the latter case. Utilization of these substances by mycobacterial metabolites depends on a series of conditions of the interrelationship between mycobacteria and the external environment. Biological variability depends on a series of momentary properties of mycobacteria and their surroundings. The rate of reactions of interchange was so rapid in the metabolites studied that it significantly hindered the use of mycobacteria labelled in this way for in vivo trials. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31746** THE INFLUENCE OF INOSITOL ON THE FIXATION OF $Ca^{45}$ IN THE BONES OF CHICKENS. Pora, E. A.; Ghircoiasiu, M. Perseca, T. Studia Univ. Babes-Bolyai, Ser. Biol., No. 1, 121-3(1963).

Three-day-old chickens were given inositol treatment daily for two weeks. Calcium-45 was then injected, and 48 hours later the animals were sacrificed. The radioactivity of the tibia and femur was measured. An increase in weight of the animals and the bones of animals treated with inositol was found, but there were no significant differences between the radioactivity of the bones of treated and non-treated animals. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31747** THYROIDAL METABOLISM OF IODINE IN THE RAT AND ITS RELATIONSHIP TO THE IODINE CONTENT OF THE DIET. Goldman, Max. Thesis, Berkeley, Calif., Univ. of California, 1964. 130p.

Decreased dietary iodine intake (0.14 μg I per gm of diet) caused a three- to four-fold decrease in $^{127}I$ content of the thyroid glands of intact rats, a 50% decrease in circulatory $PB^{127}I$, and a five-fold decrease in circulatory $^{127}I$-iodide. In rats of a second generation on the low iodine diet, the plasma iodide was too low to be measured. Intact rats on the low iodine diet had high thyroidal $^{131}I$ uptakes (52 to 70% of the injected dose) compared to those (9% of the injected dose) in corresponding animals on the iodide supplemented diet (1.0 μg I per gm of diet). Peak uptake in thyroids of low iodine rats occurred at 6 to 12 hours after injection of radioiodide, while it occurred at 24 hours in the iodide supplemented rats. Thyroid gland weights were high in the animals on low iodine diet, histologically the glands appeared highly stimulated, and T/S ratios were 400: nevertheless, it is likely that the high uptakes of $^{131}I$ were due, in part, to the extremely low concentrations of iodide circulating in the plasma; and to the consequent high specific activity of the circulating iodide after injection of radioiodide. Thyroid glands of hypophysectomized maintained on the low iodine diet appeared moderately stimulated histologically one month later. Incorporation of $^{131}I$ into thyroidal iodoprotein occurred more rapidly in thyroid glands of intact rats on the low iodine diet than in glands of rats on the iodide supplemented diet. With rats on either diet, hypophysectomy caused a decreased rate of labeling of all the thy-

roidal iodoamino acids with very little of the thyroidal label entering the $T_4$ fraction. In intact rats on either diet, the relative distribution of thyroidal $^{131}I$ became identical with that of $^{127}I$; the absolute specific activities of iodine in the iodoamino acids of the iodoprotein became approximately equal and remained that way for as long as observations were made. Results in rats are consistent with the concept that intrathyroidal iodination and deiodination reactions occur continually and lead to randomization of thyroidal iodine, both of iodotyrosines and of iodothyronines. (TCO)

**31748** THE IN VIVO USE OF DOUBLY LABELED GLUCOSE TO DETERMINE CEREBRAL METABOLISM IN HUMANS. Sacks, William (Rockland State Hospital, Orangeburg, N. Y.). p. 279-92 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

The use of glucose-$^{14}C$-$^{3}H$ for determination of cerebral metabolism is discussed. The subject is given an intravenous injection of a labeled substrate and then simultaneous arterial and venous blood samples are withdrawn at various time intervals. These blood samples are analyzed for radioactivity of the injected substrate, for end products of metabolism of the substrate ($CO_2$ and $H_2O$), and for intermediate metabolites. It was concluded that there exists a small, very active pool of glutamate in slow equilibrium with total brain glutamate. The further oxidation of glutamate is postulated to occur via the $\gamma$-aminobutyric acid pathway. (M.C.G.)

**31749** THE IMPORTANCE OF RADIOISOTOPES IN BIOLOGICAL RESEARCH. Comar, C. L. (Cornell Univ., Ithaca, N. Y.). p.3-35 of STI/PUB/90.

General aspects of the impact of the physical upon the biological sciences that have been heightened by developments in nuclear energy are reviewed. Developments in the use of radioisotopes in biological studies and recent advances in the use of radioisotopes to resolve complex metabolic cycles are discussed with emphasis on studies in domestic animals. Examples cited include the use of autoradiography and $^{45}Ca$ to study bone metabolism, the use of $^{3}H$-thymidine to study cellular changes and DNA synthesis; the use of $^{45}Ca$, $^{32}P$, $^{85}Sr$, or $^{89}Sr$ and external counting in bone accretion studies; the use of gross autoradiography to study the deposition of various elements in bone; and the use of double tracer techniques such as $^{55}Fe$ and $^{59}Fe$ to measure Fe metabolic rates, the use of $^{14}C$ and $^{3}H$ to measure amino acid metabolic rates, and the use of radioisotopes of H, C, S, or I in studies of steroid metabolism. (34 references.) (C.H.)

**31750** THE STUDY OF IODINE SECRETION INTO THE MILK OF DAIRY ANIMALS. Lengemann, F. W. (Cornell Univ., Ithaca, N. Y.). p.203-20 of STI/PUB/90.

Milking animals were given radioiodine for a period of from 14 to 30 days. Each animal served as its own control and thus served to eliminate differences due to individual variation. While a true equilibrium was not established, the amount of radioiodine secreted into the milk and excreted via the urine and feces was found to show a reasonable plateau within 10 days. Blood levels of radioiodine also followed this pattern and allowed meaningful comparisons between plasma and milk. Using $^{131}I$ as the label for dietary iodide, it was observed that cows put about 1% of daily intake of iodide into each liter of milk, while the goat averaged about 60% per liter. When comparisons of milk iodide and plasma iodide were made, milk plasma ratios ranging from 0.6 to 5.5, and from 2 to 12 were observed in cattle and goats, respectively. When antithyroid compounds, such as high levels of iodide, perchlorate and KSCN, were administered to cattle and goats, the ability of the mammary gland to concentrate iodide decreased markedly. In the case of cattle, m/p ratios as low as 0.3 were observed. The data suggest the presence of a mechanism which actively concentrates iodide in milk. Experiments with exogenous thyroxine show that this hormone shows a limited but definite ability to reduce the transfer of iodide across the mammary gland from plasma to milk and also in the reverse direction. Other experiments showed that radioiodine given as iodate ($^{125}I$) appears in milk to a somewhat greater extent than radioiodine ($^{131}I$). After administration of the two radioiodines stopped, it was observed that the amount of $^{125}I$ in the milk decreased quicker than the $^{131}I$. These findings suggest an incomplete conversion of iodate to iodide in the body of the dairy cow and differences in the transfer of the two forms of iodine across the mammary gland. (auth)

**31751** A MATHEMATICAL EVALUATION OF THE EXCRETION CURVES OF IODINE-131 IN MILK OF COWS. Giese, W.; Lengemann, F. W.; Wentworth, R. A. (Cornell Univ., Ithaca, N. Y.). p.221-30 of STI/PUB/90.

Milk radioiodine concentration curves for cows after ingestion of single or consecutive daily doses of $^{131}I$ are presented. From a mathematical analysis of the general curves depicting milk radioiodine content, it is possible to calculate curves relating to a specific isotope of iodine. From these curves it is possible to predict how long it will take for the milk of a herd just changed from contaminated pastures to stored feeds to return to levels of radioiodine that are acceptable. (auth)

**31752** GASTROINTESTINAL SITES OF ABSORPTION AND SECRETION OF Ca, P, Zn, AND I IN DAIRY CATTLE. Cragle, R. G.; Miller, J. K.; Chandler, P. T. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). p.499-515 of STI/PUB/90.

Thirty dairy animals of various ages were studied to determine gastrointestinal sites of mineral absorption and endogenous secretion. Cerium-144 ($^{144}Ce-^{144}Pr$), orally administered until an equilibrium existed between intake and excretion, was used as the unabsorbed reference marker. The animals were subsequently sacrificed and ingesta samples taken from the rumen (rumen-reticulum), omasum, abomasum, six small intestinal sections, cecum, and two large intestinal sections. The ratio of % of dose of Ca, P, Zn, or I/% of dose of $^{144}Ce$ was used to indicate net endogenous secretion into the tract (value greater than 1) or net absorption (value less than 1). Calcium was constant in the rumen of young animals, 0.5 in the abomasum (50% net absorption), 0.8 in the first part of the small intestine with absorption occurring in the first half of the small intestine. Phosphorus concentration was 1.9 in the rumen (presumably from salivary secretions), 0.8 in the abomasum, 3.5 to 5.2 in the first section of the small intestine and was absorbed for the remainder of the tract. Zinc was absorbed to about 0.5 in the abomasum, endogenously secreted to 2.0 in the first section of the small intestine and was absorbed for the remainder of the small intestine. Iodine was absorbed to 0.2 in the rumen, endogenously secreted to 7.0 in the abomasum and to nearly 8.0 in the first section of the small intestine. Absorption occurred through the remainder of the tract. In one experiment involving 3 mature and 3 young animals, $^{144}Ce$ and $Cr_2O_3$ were administered simultaneously as a check on the validity of using $^{144}Ce$. Close agreement of values resulted. Typically, in ruminating animals, 63.3% of the tract contents were in the rumen, 12.1% in the omasum, 4.6% in the abomasum, 10.5% in the small intestine, 4.2% in the cecum and 5.1% in the large intestine. Since major absorption occurs in more than one location in the gastrointestinal tract for all of the elements studied, physiological and nutritional implications need to be evaluated. (auth)

**31753** ANTIGOITROGENIC PROPERTIES OF RUTABAGA (BRASSICA RUTABAGA) JUICE. St. Bobek (College of Agriculture, Cracow, Poland). p.517-31 of STI/PUB/90.

Plants of Brassica were found to act as goitrogens, provoking a thyroid hypertrophy. Antithyroid compounds: 1-5vinyl-2-thiooxasolidone (goitrin), polysulphides, and thiocyanates are the goitrogenic factor. Previous research showed that the goitrogenic activity of these plants is not constant, but is subject to a strong fluctuation. Results are reported from studies that show that rutabaga, although considered as one of the most active plants of this group, has shown sometimes an antigoitrogenic and thyroid stimulating effect. Studies were carried out on three groups of rabbits receiving: 50 ml of rutabaga juice + 120 mg KSCN;

50 ml of carrot juice + 120 mg KSCN; and 50 ml of water + 120 mg KSCN. Plant juice and water with thiocyanates were introduced each day during a period of 24 to 28 days into the stomach of the rabbit by means of a stomach pump. The following measurements were carried out: thyroid weight, biological half-time of $^{131}I$ ($T_b\frac{1}{2} - ^{131}I$), Protein Bound Radioiodine ($PB^{131}I$), Conversion Ratio (CR), and thiocyanate level in the thyroid gland. At the end of the experiment, after killing the animals, the thyroid weight and thiocyanates level were recorded. Measurements with $^{131}I$ were carried out during a period of nine days. Radioiodine was injected subcutaneously in the amount of 13 $\mu$C per animal. Animals receiving carrot juice showed the highest weight of the thyroid and those receiving rutabaga juice the lowest one. The difference in thyroid weight between the groups was significant in males and showed a strong fluctuation in the females. The shortest $T_b\frac{1}{2}$ of $^{131}I$ in thyroid was observed in animals of both sexes receiving rutabaga juice. The longest $T_b\frac{1}{2} - ^{131}I$ was observed in the group of males receiving water, and in the group of females receiving carrot juice. The $PB^{131}I$ and CR value was the highest in the group of males and females receiving rutabaga juice and the lowest in females receiving carrot juice and males receiving water. The largest thiocyanates level was found in thyroids of males and females receiving carrot. No significant difference was observed between the two other groups. The results indicate that rutabaga juice, regarded as a strongly goitrogenic plant, may also have antigoitrogenic properties and possibly thyreostimulating effect. The carrot juice in this experiment showed a goitrogenic influence and decreased the thyroid activity. (auth)

**31754** THYROGLOBULIN IMMUNITY AND THYROIDAL-$I^{131}$ SECRETION AND FUNCTION. Premachandra, B. N. (Veterans Administration Hospital, St. Louis, Mo. and Washington Univ., St. Louis, Mo.). p.533-57 of STI/PUB/90.

The variation in thyroid hormone secretion rates in individuals, which in turn may explain differences in productivity in domestic animals was studied. The studies formed a part of comprehensive investigations of the effects of thyroglobulin antibodies on thyroid function and secretion. Experimental immunization was first attempted and groups of guinea pigs were injected with electrophoretically pure bovine thyroglobulin once weekly for three weeks and the antibody titer was estimated by tanned red cell hemagglutination technic. At about nine weeks after immunization maximum thyroglobulin antibody levels were observed and the following parameters were evaluated using $^{131}I$ as a tracer. Thyroid hormone transport in control and immunized animals was studied by conventional agar and paper electrophoresis. Thyroid secretion rate (TSR) was estimated by the replacement technic which is based on the classical reciprocal relationship between thyroid and pituitary and involved administration of graded levels of thyroxine exogenously until all thyroidal $^{131}I$ secretion was completely inhibited. The half-life ($t\frac{1}{2}$) of thyroid hormones was estimated by injecting $^{131}I$-labeled thyroxine and triiodothyronine and determining the radioactivity of blood at frequent intervals. Protein bound iodine was determined by conventional analytical technics. It was found that both thyroxine and triiodothyronine were bound by circulating thyroglobulin antibody and TSR was diminished in immunized animals. The $t\frac{1}{2}$ of labeled thyroxine and triiodothyronine was increased over two hundred percent in immunized animals with a concomitant elevation of PBI. These observations are of significance in not only offering some fundamentally new concepts in the etiology of hypothyroidism but also in an understanding of the physiology of thyroid secretion and its variation in different individuals in whom thyroid autoantibodies can be found without any thyroid disease. (auth)

**31755** STORAGE OF IODINE BY THE HYPERPLASTIC THYROID. Middlesworth, L. Van (Univ. of Tenn., Memphis). p.577-93 of STI/PUB/90.

Stimulation of thyroid function by TSH causes increased release of stored hormone. Depletion of thyroid iodine by prolonged feeding of a low iodine cereal diet resulted in hyperplasia and colloid goiter in hamsters and hyperplastic goiter in rats. The animals had radioiodine uptakes of 80 to 90% in 6 hours and iodine release rates of 50% in 10 to 15 hours. Iodine-125 was used to measure chronic release rates because this isotope minimized the radiation dose and permitted accurate measurements of release for 60 to 80 days. The $^{125}I$ release slowed progressively after the first day. After 10 days, 10 to 20% of the initial $^{125}I$ remained in the thyroid with a half-time of 5 to 10 days; large doses of antithyroid drugs increased release for only 2 days. The last 1% of the thyroid $^{125}I$ had a half-life of more than 30 days and this was not influenced by TSH or by antithyroid drugs given for 20 days. After that time $^{131}I$ uptake in absence of antithyroid agents was still 90% in 8 hours and 50% of the acute uptake was released in 11 hours. Chromatographic analysis of the thyroid $^{131}I$ which rapidly concentrated showed: unhydrolyzed origin material 3%, MIT 40%, DIT 35%, $T_4$ 10%, $T_3$ 5%, I 5%. Chromatographic fractionation of the chronically retained $^{125}I$ revealed 50% organically bound iodine at the origin; this resisted vigorous digestion by pancreatin and pronase, 30% was MIT, less than 10% was DIT, iodide and unidentified substances. In vivo the glands were so hyperactive that probably MIT would be readily deiodinated and serve as a source of iodine; however, the slow in vivo release of this iodinated component minimized the availability of thyroid hormone from this source. The slow release is independent of TSH and may serve as a minimal supply of iodine and thereby prevent severe myxedema during iodine depletion. These results show that the hyperplastic thyroids slowly accumulate 1 to 10% of the body iodide into a slowly released iodinated component, although 90% of the blood iodine is rapidly accumulated and rapidly released each day. The slow component is not directly stimulated by TSH; it has not been completely hydrolyzed, but MIT was the major product of hydrolysis. (auth)

**31756** RELATIONSHIP BETWEEN EXPERIMENTAL MAGNESIUM DEFICIENCY IN CALVES AND CALCIUM METABOLISM MEASUERED BY $Ca^{45}$. Larvor, P.; Girard, A.; Brochart, M. (Institut Pasteur, Paris). p.659-75 of STI/PUB/90.

Experiments were made on eight calves, of which four were fed on semi-synthetic milk with a low magnesium content (20 mg/litre), and the four others on the same milk with magnesium added (190 mg/litre). The standard effects of deficiency (reduction in growth, crises of muscular tetanization, lowering of magnesium in the blood), were observed in the deficient animals. Disturbances of calcium metabolism were also noted in these animals, manifesting themselves mainly in hypocalcaemia, a drop in the alkaline phosphatase of the plasma, and marked parathyroid hyperplasia. In an attempt to clarify the origin and the quantitative importance of these disturbances, the calcium metabolism of the calves was investigated by the isotopic method. Results showed that in sucking calves there are at least five different calcium compartments; magnesium deficiency causes, even before the appearance of the symptoms, a retardation in the over-all rate of depletion of calcium stores; this latter phenomenon is caused by a considerable retardation of the calcium exchanges of the bone; and the calcium stores are not affected at this pre-clinical stage of magnesium deficiency. The method of action of magnesium deficiency is discussed and a pathogenic hypothesis is postulated, involving an original disturbance of the bone calcium metabolism, with magnesium essential to the action of parathormone, and hypocalcaemia and a secondary parathyroid reaction occurring as a result. (auth)

**31757** MAGNESIUM, CALCIUM, PHOSPHORUS AND STRONTIUM INTERRELATIONS. Clark, I. (Columbia Univ., New York). p.677-92 of STI/PUB/90.

Feeding of magnesium ions to rats was shown to increase elimination of skeletally bound $^{89}Sr$. Further investigations indicated that administration of magnesium together with $^{85}Sr$ reduces the skeletal uptake of the isotope. Studies were

initiated to determine the mechanism by which magnesium increases radioactive strontium elimination and to study magnesium, calcium, and phosphorus interrelations. It was found that the efficacy of supplemental dietary magnesium ions in increasing the elimination of skeletally bound $^{89}Sr$ was dependent on the Ca/P ratio of the diet and that the main excretory route of the isotope was by the kidneys. If the Ca/P ratio of the diet was 4 or greater, or if the diet contained only traces of phosphorus, magnesium decreased both fecal and urinary $^{89}Sr$. If the Ca/P ratio of the diet was 2 or less, or if the diet contained only traces of calcium, the net elimination of isotope was increased by the supplemental magnesium, although urinary $^{89}Sr$ was increased and fecal $^{89}Sr$ decreased. The calcium and phosphorus balance studies indicate that increased urinary $^{89}Sr$ resulting from magnesium administration was accompanied by increased urinary calcium and decreased urinary phosphorus, while decreased urinary $^{89}Sr$ was accompanied by decreased urinary calcium but with no significant changes in urinary phosphorus. Regardless of the ratio of Ca/P in the diet, magnesium always decreased fecal calcium resulting in a more positive calcium balance. If dietary Ca/P was 1 or less, magnesium made the phosphorus balance more positive. The influence of magnesium on calcium and phosphorus metabolism is discussed in the light of the above findings. (auth)

**31758** APPLICATION OF METHODS OF MATHEMATICAL STATISTICS IN EVALUATION OF THE RESULTS OF EXPERIMENTS CARRIED OUT BY MEANS OF RADIOACTIVE ISOTOPES IN THE FIELD OF ANIMAL NUTRITION AND PHYSIOLOGY. Myslivec, V. (School of Agriculture, Prague). p.805-33 of STI/PUB/90.

There exist two kinds of nuclear counters today: counters for registering the number of impulses for a fixed period of time and counters registering time for a chosen number of impulses. During research work with small activities it is necessary to ascertain whether the observed results are statistically significant or not. Statistical characteristics for both types of the nuclear counters and the evaluation of results of experiments using small activities are discussed. The disintegration of radioactive isotopes which is considered to be a stochastic process, and it is explained why samples of observation according to the probability can be replaced by samples of observations considered in a period of time. The distribution function is discussed on the presumption that time is the stochastic variable while the number of impulses is constant. It is further indicated how it is possible to derive Poisson's distribution function of probability, where the stochastic variable is the number of impulses, while the time interval fixed in advance is constant. In both cases the respective statistical characteristics are derived and it is shown how, by means of the ascertained values of these characteristics, the evaluation of the obtained results of experiments is carried out. (auth)

**31759** RESEARCH ON THE BIOSYNTHESIS OF THE STRAIGHT CHAIN HYDROCARBON, $C_{27}H_{56}$, STUDIED WITH $^{3}H$ AND $^{14}C$ PRECURSORS. A. Breccia (National Center for Radiation Chemistry and Radioelements of CNR, Bologna) and A. Crespi. p.91-4 of "EUR-2200.e."

The role of acetate in the biosynthesis of the linear paraffin, $C_{27}H_{56}$, was studied in wistaria flower cultures (Wistaria sinensis) in solutions containing $^{3}H$ or $^{14}C$ labeled precursors. The results indicate that active acetate plays a fundamental role in the synthesis of straight chain aliphatics. Reaction mechanisms are discussed and experimental procedures are described. (C.H.)

**31760** BIOSYNTHESIS OF LABELED MOLECULES: MECHANISM OF BIOSYNTHETIC REACTIONS AND PRECURSORS OF FURANIC TERPENES AND PHYTOSTEROLS. Abbondanza, A. (Universita, Bologna); Breccia, A.; Crespi, A. p.95-101 of "EUR-2200.e."

Mechanisms involved in the biosynthesis of furanic terpenes and sterols by plants were investigated. The pharmacologically interesting furanic terpene, marrubine, was prepared from cultures of mint (Marrubium vulgare) and 22,23-dihydrostigmasterol was prepared from cultures of wistaria flowers (Wistaria sinensis) in solutions with $^{3}H$ or $^{14}C$ labeled precursors, including acetate, succinic acid, or mevalolactone. Reaction mechanisms involved are discussed and the experimental procedure is described. (C.H.)

**31761** RESEARCH ON THE BIOGENESIS OF FUROCOUMARINS USING $^{3}H$ AND $^{14}C$ PRECURSORS. Caporale, G.; Breccia, A.; Rodighiero, G. (Universita, Padua and National Center of Radiation Chemistry and Radioelements of the CNR, Padua). p.103-7 of "EUR-2200.e."

The synthesis of two furocoumarins, psoralen and bergapten, by freshly cut fig (Ficus carica) leaves in culture was studied using $^{3}H$ and $^{14}C$ as tracers. Results indicate that shikimic acid, phenylalanine, and cinnamic acid are precursors and that acetate and p-hydroxylated aromatic compounds such as tyrosine and p-cumaric acid are not incorporated. It is pointed out that the natural furocoumarins constitute a group of substances of notable interest from the biological and chemical point of view due to their skin photosensitizing action in some fruits and plants. (C.H.)

**31762** APPLICATION OF THE AUTORADIOGRAPHIC TECHNIQUE TO THE STUDY OF THE EXCRETION IN THE COLEOPTEROUS INSECT TENEBRIO MOLITOR L. Marcuzzi, G.; Degasperi, P. (Universita, Padua). p.127-9 of "EUR-2200.e."

Penicillin-$^{14}C$ was used in the autoradiographic study of the excretory function of malpighian tubules of the coleopterous insect Tenebrio molitor. Results indicated that penicillin is eliminated by malpighian tubules through a process of passive diffusion, perhaps reinforced by secretion when the substance is very diluted in the hemolymph. (C.H.)

**31763** TOPOGRAPHICAL DISTRIBUTION OF $^{131}I$-LABELED STAPHYLOCOCCAL ENTEROTOXIN IN SENSITIVE ANIMALS (YOUNG CATS). Arghittu, C.; Lenzerini, L.; Rossi-Torelli, M. (C.A.M.E.N., S. Piero a Grado, Pisa, Italy). p.131-9 of "EUR-2200.e."

Staphylococcal enterotoxin, labeled with $^{131}I$, was injected intraperitoneally into cats. An equal quantity of $^{131}I$ in the form of NaI was injected into control animals and all animals were sacrificed after 0.5, 1, 2, 4, and 24 hr and samples of blood, encephalon, stomach, small intestine, liver, spleen, adrenal glands, and kidneys were counted for radioactivity. Additional brain samples were also counted to determine the distribution of toxin in various regions of the brain. Results indicated that radioactivity of the adrenal glands and kidneys of the animals given toxin was much higher than controls, the radioactivity of stomach and intestine was high in both groups, and radioactivity of the brain was the same for both groups. The most characteristic symptom of staph toxin poisoning, vomiting, did not seem to be associated with toxin action on the central nervous system. (C.H.)

**31764** PREPARATION AND USE OF LABELED CYTOTOXIC PURINE DERIVATIVES. Ballweg, H. (Universitat, Heidelberg). p.141-5 of "EUR-2200.e."

Kinetin, a purine derivative plant growth factor, was found to be essential for cell division in plant tissue cultures. Kinetin was identified as 6-furfuryl-aminopurine. A $^{14}C$-labeled analog of kinetin, 6-histaminopurine, was prepared and used in studies on the mechanism of activity of this compound in sarcoma and carcinoma cells in tissue culture. A differential action of 6-histaminopurine was demonstrated in tumor cells in culture but was not observed in tumor-bearing animals. (C.H.)

**31765** TRITIUM-LABELED ACTINOMYCIN. PREPARATION AND CYTOLOGICAL DISTRIBUTION IN HUMAN CELLS CULTURED IN VITRO. Ciferri, O. (Universita, Pavia, Italy), Fraccaro, M.; Albertini, A.; Cassani, G.; Mannini, Anna; Tiepolo, L. p.147-63 of "EUR-2200.e."

Cultures of Streptomyces antibioticus were used in the preparation of tritium-labeled actinomycin. Autoradiogra-

phy was used to show the distribution of labeled actinomycin in human cells in tissue culture. Results are reported from studies on the effects of actinomycin on cell growth, nuclear morphology, chromosomes, and on mitosis. (C.H.)

**31766** METABOLIC STUDIES WITH SPECIFICALLY LABELED NICOTINE MOLECULES. Decker, K.; Sammeck, R. (Universitat, Freiburg i. B.). p.165-72 of "EUR-2200.e."

Nicotine catabolism was studied in cell free extracts of nicotine adapted Arthobacter oxidans and a rabbit liver extract using $^{14}CH_3$-L-nicotine and 2'-$^{14}$C-DL-nicotine. Qualitative as well as quantitative results were obtained regarding the catabolic routes of the base and the intermediates of these pathways using combined radiographic and spectrophotometric analysis of the degradation products. (C.H.)

**31767** PHENOBARBITONE 2-$^{14}$C AND 5-$^{14}$C: COMPARISON OF THEIR METABOLISM. Benakis, A.; Glasson, B. (Universite, Geneva). p.179-85 of "EUR-2200.e."

Labeling of molecules in several positions enables the various possible routes for catabolism to be ascertained. The importance of knowledge of chemical reactions that give rise in vivo to new compounds after the administration of drugs is discussed. The metabolism of a 2-$^{14}$C- and 5-$^{14}$C-phenobarbitone, the classical barbiturate and anti-epileptic drug, was studied in rats. Results showed that certain types of conversion could go unnoticed. (C.H.)

**31768** VALIDITY OF THE UTILIZATION OF $^{131}$I THYROXINE IN THE EVALUATION OF THE PERIPHERAL TURNOVER OF THE THYROID HORMONE. Delange, F. M.; Ermans, A. M. (Universite, Brussels). p.187-92 of "EUR-2200.e."

Tracer methods for the study of thyroxine metabolism in man, using $^{125}$I, $^{127}$I, $^{131}$I, or combinations of two of these isotopes, were compared. Results are summarized for studies in healthy individuals and those with thyroid diseases. The validity of using $^{131}$I-thyroxine in the evaluation of the peripheral turnover rate was established. (C.H.)

**31769** DEIODINATION AND SUBCELLULAR DISTRIBUTION OF THYROID HORMONES LABELED WITH $^{125}$I AND $^{3}$H. Jacquemin, C.; Nunez, J.; Rappaport, L.; Brun, D.; Roche, J. (College de France, Paris). p.193-207 of "EUR-2200.e."

A number of thyroxine substrates labeled with $^{125}$I, $^{131}$I, or tritium were used in an effort to clarify the nature and distribution of the products obtained after the deiodination of thyroxine. Results are included from in vivo studies and in vitro studies in rats. Possible explanations of differences in results obtained in in vivo and in vitro studies are discussed. (C.H.)

**31770** ON THE CORRELATION BETWEEN SPECIFIC ACTIVITIES OF HAEM AND GLOBIN AND OF THEIR RATIO WITH THE HAEMOGLOBIN CONTENT IN DUCK BLOOD INCUBATED IN VITRO WITH 2 $^{14}$C GLYCINE. Bianco, L.; Lazzarini, E.; Ragnotti, G.; Scolari, A. (Politecnico, Milan). p.209-15 of "EUR-2200.e."

Results are reported from studies of the specific activities of heme and globin and their ratio with hemoglobin content in duck blood incubated in vitro with $^{14}$C-glycine. (C.H.)

**31771** EXPERIENCES IN METABOLIC STUDIES WITH RADIOACTIVELY LABELED PHARMACEUTICALS (WITH SPECIAL REGARD TO $^{3}$H-CYCLOPHOSPHAMIDE WITH HIGH SPECIFIC ACTIVITY). Graul, E. H. (Universitat, Marburg, Ger.). p.217-52 of 'EUR-2200.e."

Developments in the preparation and use of radioactivity labeled pharmaceuticals are discussed. Emphasis is placed on studies of compounds used in cancer chemotherapy, using cyclophosphamide as an example. The preparation and results of metabolic studies are discussed for $^{3}$H-cyclophosphamides, $^{35}$S-labeled sulfur compounds such as methionine esters, nitrogen mustards labeled with tritium, $^{14}$C, or $^{131}$I, and Endoxan labeled with $^{14}$C and tritium. (C.H.)

**31772** INCORPORATION OF TRITIATED THYMIDINE DNA AND KINETICS OF ASCITES-TUMOR CELLS. Benassi, E.; Piccotti, F. (Universita, Turin). p.253-7 of "EUR-2200.e."

Thymidine labeled with tritium and autoradiographic techniques were used to study the growth of Ehrlich's ascites tumor cells after introduction into the peritoneum of experimental animals. Data on cell growth and DNA synthesis times are presented. (C.H.)

**31773** KINETICS OF $^{131}$I-ALBUMIN AND $^{131}$I-TRANSFERRIN IN LYMPH. Winchell, H. S.; Pollycove, M.; Kusubov, N.; Fawwaz, R. (Univ. of California, Berkeley). p.273-86 of "EUR-2200.e."

Human serum albumin and transferrin, both labeled with iodine-131, were used singly and together to determine the kinetics of the distribution of intravenously administered interstitial albumins in the lymph and plasma of dogs. Evidence is presented that demonstrates that the liver has a remarkably rapid turnover of interstitial fluid albumin and that liver lymph is the major source of very rapidly appearing labeled albumin and transferrin in the thoracic duct lymph following intravenous administration. A kinetic model for albumin in the interstitial fluid spaces of the body is presented. (C.H.)

**31774** DISTRIBUTION OF $^{131}$I-ALBUMIN AND $^{125}$I-CHYLOMICRA IN RENAL TISSUE. Pinter, G. G. (Univ. of Maryland). p.287-92 of "EUR-2200.e."

Albumin labeled with $^{131}$I and chylomicra labeled with $^{125}$I were used as tracers in studies of renal blood circulation in dogs. Results are reported from studies in which the labeled compounds were injected intravenously and the hilus of one kidney tied off 20 to 30 min. later, the kidney removed and tissue samples analyzed for radioactivity. Preliminary results indicate that the distribution space for chylomicra is smaller than that for albumin in dog kidney. (C.H.)

**31775** UPTAKE OF PROTEINS BY GROWING TISSUES. Ghose, T. (Univ. of Aberdeen, Scotland). p.293-5 of "EUR-2200.e."

Protein metabolism in rapidly growing tumor and normal tissues was studied by fluorescent labeling methods in vivo in mice and in vitro in tissue cultures. Results indicated that rapidly growing tissues share with malignant cell the capacity to take up intact protein molecules. Reaction mechanisms were not defined. (C.H.)

**31776** DYNAMICS OF INTERMEDIARY METABOLISM USING CARBON-14 RESPIRATION. Tolbert, B. M.; Bigler, W. N.; Cozzetto, F. J. (Univ. of Colorado, Boulder). 305-38 of "EUR-2200.e."

The use of $^{14}$C respiration to determine the dynamics of intermediary metabolism is discussed. The rate of catabolism of a $^{14}$C labeled substrate to $^{14}CO_2$ is a function of the metabolic pathways and the dynamics of the metabolic process. These biochemical rate processes are modified in animals by the kinetics of circulation and tissue and cellular transport. The $CO_2$ produced enters a $CO_3$-bicarbonate pool and is slowly lost in the respired air, where it can be made to produce an electrical signal. It is pointed out that the ability to analyze and interpret respiratory $^{14}CO_2$ data in terms of substrate catabolism depends on our ability to define the bicarbonate pool and calculate its effects. The metabolism of glucose is reviewed in terms of results from tracer studies using $^{14}$C. A number of clinical studies based on breath excretion of $^{14}CO_2$ after the administration of $^{14}$C labeled substrates are reviewed. These include the measurement of metabolic abnormalities of genetic origin, the differences between folic acid and vitamin $B_{12}$ deficiency, the metabolic nature of obesity, the role of thyroid hormones, an assessment of steatorrhea, and the action of various drugs. (56 references) (C.H.)

**31777** AUTORADIOGRAPHIC STUDIES OF MOTOR ENDPLATES WITH TOXIFERINE. Waser, P. G. (Universitat, Zurich). p.365-71 of "EUR-2200.e."

Toxiferine is an alkaloid of calabash curare that pro-

duces sustained paralysis of skeletal muscles. It is excreted very slowly and is apparently not metabolized. The mechanism of the pharmacological effect of toxiferine on nerve endplates was investigated in mice after the injection of various doses of $^{14}C$-toxiferine. Autoradiography was used to establish reaction sites involved. (C.H.)

**31778** AUTORADIOGRAPHY OF $H^3$-THYMIDINE AND $C^{14}$-THYMIDINE IN BONE MARROW USING A DOUBLE EMULSION TECHNIQUE. Kesse, M.; Harriss, E. B.; Gyftaki, E. (Univ. of Athens). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/57, 13p. (CONF-650507-7). ORINS.

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

A new method was developed in order to study the generation time of bone marrow cells in cultures, after double labeling with $^3H$- and $^{14}C$-thymidine, by means of a double emulsion autoradiographic technique. The bone marrow smear is covered with a very thin layer of the fine grain Gevaert emulsion NUC 715. After an exposure suitable for the $^3H$-thymidine (1-5 days) the emulsion is processed and the bone marrow can be stained adequately through the thin emulsion. It is then dipped in a 7% solution of celloidin in amyl acetate to protect the stain during subsequent procedures (celloidin in ether-alcohol mixture removes the stain). The specimen is then dipped in Kodak NTB-2 emulsion having a larger grain size than the first emulsion, and exposed for $^{14}C$-electrons (2-6 weeks). The second emulsion can then be processed without affecting the staining of the bone marrow smear. The celloidin layer is sufficiently thick to absorb all $^3H$-electrons so that an increase in grain density in the second emulsion is due to $^{14}C$-electrons only. Moreover the celloidin layer still permits good autoradiographic resolution in the second emulsion. Autoradiographs in the first and second emulsion are easily recognized by the difference in grain size. It is thus possible to distinguish between cells cintaining $^3H$-thymidine only and cells containing $^{14}C$-thymidine only or both $^3H$- and $^{14}C$-thymidine. The interpretation of the results is discussed. (auth)

**31779** COMPUTER PROGRAMS FOR MULTIPLE LABELING TECHNIQUES INVOLVING TWO OR MORE RADIOIODINES. Pressman, D.; Pressman, R. (Roswell Park Memorial Inst., Buffalo). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/36, 16p. (CONF-650507-14)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

By the use of three iodines as in the Triad Label Technique data of much greater significance can be obtained because antitumor antibodies, antinormal tissue antibodies, and control globulin can all be assayed simultaneously in the same tumor. Up till now limited use was made of the Triad Label Technique because of the short lives of the third isotope available and because of the amount of computation required. Programs in Fortran IV for use on the IBM 7040, 7044 etc. computers were devised which make the Triad Label Technique a practical method, not only for tumor studies but for protein structure studies. Computer programs for Paired Label studies were developed. (P.C.H.)

**31780** THE USE OF A TRIPLE TRACER TECHNIQUE IN STUDIES OF BONE METABOLISM. Mueller, W. A. (Gesellschaft fur Strahlenforschung mbH, Munich). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/17, 13p. (CONF-650507-31)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

A method of measuring strontium, calcium, and phosphorus at the same time was developed using a liquid scintillation counter combined with $\gamma$ spectrometry. For such triple tracer experiments $^{45}Ca$, $^{85}Sr$, and $^{32}P$ were administered in mice. Samples of ashed bone, plasma, and excrement were collected at different times after administration. To fit the samples to liquid scintillation counting two methods for getting colorless solutions are discussed: decolorizing with charcoal; and oxidizing with perchloric acid. The counting efficiency in both types of preparation and the economy in practice were proved. The liquid samples were dissolved in a dioxane-based scintillation fluid. The $\beta$-nuclides $^{45}Ca$ and $^{32}P$ were measured in two different energy channels of a liquid scintillation spectrometer. $^{85}Sr$ was determined by a multichannel analyzer. The described technique is especially advantageous for the study of the effects of differently applied strontium (oral or injected); furthermore the influence of some mineral-enriched diets on strontium retention and excretion could be explained in relation to calcium and phosphorus content of diet and body. (P.C.H.)

**31781** POSSIBILITY OF MAKING A QUANTITATIVE STUDY OF THE PRECIPITIN REACTION USING GAMMA-RADIOACTIVE TRACERS. Bonev, L.; Robev, S.; Todorov, S. (Scientific Research Inst. for Radiology and Radiation Safety, Sofia). Vienna, International Atomic Energy Agency 1965, Preprint No. SM-61/26, 7p. (In Russian) (CONF-650507-28). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Results of the quantitative determination of the precipitin reaction (formation of an antigen-antibody complex) by labeling the precipitating components with gamma-radioactive tracers which do not chemically interact with albuminous molecules are reported. As tracers it is possible to use chrome-manganese and nickel-copper compounds, whose tendency to hydrolyze permits the fixation of the radioactive tracer on the antigen and antibody, respectively. The radioactivity of the components is determined by a multi-channel pulse-height analyzer. The results obtained show that the precipitation curve, plotted on the basis of radiometric data, closely corresponds to the curve plotted by the well-known quantitative methods used to determine albumin. The possibilities of using the method described are discussed. (auth)

**31782** AUTOMATIC SAMPLE AND DATA PROCESSING IN STUDIES OF CALCIUM METABOLISM IN RATS. Onkelinx, C.; Richelle, L.; Debras, J. (Universite, Liege). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/1, 17p. (In French). (CONF-650507-23). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Work on Ca metabolism in rats was facilitated by the development of automatic methods for measuring the samples and processing the data, and these methods are described. In the processing of samples the radioactivity measurements are carried out on small (20-40 $\lambda$) of plasma, removed at repeated intervals, and on total quantities of feces and urine excreted in a given period. The measuring apparatus used comprises a feed, a low-background anti-coincidence counter, and a digital computer; the measurements obtained from the computer are then recorded on a printer. The novel features of the sample preparation techniques used, and the performance achieved by the measuring apparatus, are discussed, with special reference to the (statistical) counting conditions, which are checked by the computer each time new measurements have to be calculated. Data processing is done by an IBM-7040 digital computer, into which are fed the program for the calculation and all the raw experimental data in the form of punched cards, separately for each animal. There are three stages to the data-processing operation: converting the raw data and calculating the standard deviation shown by the measurements for each sample; analyzing the specific activity curve of the plasma and expressing it in mathematical terms; comparing the theoretical curve with the experimental measurements; and evolving the complete model by calculating the various parameters. The results are printed out in clear on paper and also punched onto cards by the computer, with a view to further processing later. The advantages of digital over analogue computers for this work are discussed. (P.C.H.)

# Radiation Effects

*Refer also to abstracts 32627 and 32648.*

**31783** (ABCC-61-62) ANNUAL REPORT, JULY 1, 1961–JUNE 30, 1962. (Atomic Bomb Casualty Commission, Hiroshima (Japan)). Contract AT(49-1)-Gen-72. 158p. Dep.(mn); $5.00(cy), 3(mn) CFSTI. (In Japanese and English).

Data are summarized from clinical examinations of residents of Hiroshima and Nagasaki exposed to radiation during the explosion of atomic bombs in 1945. Over 90% of the subjects still living and available for contacting were examined, representing about 80% of the original total study sample. Data are presented on persons exposed as adults, as children, and in utero. Emphasis was placed on clinical manifestations that might be related to late effects of radiation. Data are presented from studies on mortality, morbidity, specific diseases or abnormalities, genetics, growth and development, fertility, and radiation dose measurements. A list is included of 93 publications during the period covered by this report. (C.H.)

**31784** (EUR-2415.e) THE EFFECT OF NICOTINAMIDE ON X-IRRADIATED SUSPENSION CULTURES OF RAT BONE MARROW CELLS. Whitfield, J. F.; Youdale, T.; Brohee, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 16p. Dep.(mn).

During the first 6 hours after x irradiation (250 to 1500 R) of suspension cultures of rat bone marrow, the nuclei of the various blast cells, promyelocytes, myelocytes, normoblasts, and cells of the lymphocyte family, lost their reticular structure and became structurally homogeneous. This change could be retarded by adding nicotinamide (0.075M) to the culture immediately after irradiation. Lactate production was slightly stimulated by irradiation (500 R). Lactate production in both normal and irradiated cultures was reduced by exposure of the cells to nicotinamide. (EURATOM)

**31785** (NP-15072(p.17-28)) THE EFFECTS OF IONIZING RADIATIONS ON BIOCHEMISTRY OF MAMMALIAN TISSUES. II. FURTHER STUDIES ON THE INHIBITORY EFFECT OF X RADIATION ON THE DEVELOPMENT OF MICROSOMAL ENZYMES OF THE LIVER. Kinoshita, Florence; DuBois, Kenneth P. (Chicago Univ., Ill. Air Force Raditation Lab.).

Measurements were made of the effect of sublethal doses of x irradiation on the development of the enzyme system in the livers of young male rats that catalyzes the detoxification of EPN. Doses of 400 R and 600 R of x ray produced marked inhibition of the enzyme activity as evidenced by about one-half the normal enzyme level at 35 days of age. The administration of estradiol and progesterone at a level of 2 mgm/kgm/day had no stimulatory effect on the level of the EPN detoxification system in the livers of adult female rats, but testosterone, desoxycorticosterone, and cortisone at the same dosage levels produced small increases in activity after 7 days of treatment. Exposure of 23-day old rats to 400 R of x ray immediately before the administration of 50 mgm/kgm of phenobarbital did not inhibit induction of enzyme synthesis by phenobarbital. The absence of an effect by radiation on enzyme induction in contrast to the inhibition of the normal development of the enzyme activity demonstrates that the induction process and the normal development of enzyme activity involve different mechanisms. The effect of mechlorethamine (HN2) hydrochloride on the development of the detoxification enzymes for EPN was measured by administration of high sublethal doses to weanling male rats. The measurements demonstrated that HN2 has a marked inhibitory effect on the development of the enzyme system and thus resembles x ray in this respect. The effect of 400 R of x ray on the O-demethylase activity of the livers of young male rats was measured. It was found that there is no difference between the enzyme activity in the livers of adult male and female rats and weanling male rats in the normal O-demethylase activity. Exposure of weanling rats to radiation had no effect on the enzyme activity thus providing further evidence that the effect of radiation on other microsomal systems involves inhibition of the enzyme synthesis reaction which leads to a sex difference in enzyme activity. (auth)

**31786** (NP-15072(p.29-36)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. III. FURTHER STUDIES ON THE ADENOSINE TRIPHOSPHATASE ACTIVITY OF THE HEMATOPOIETIC TISSUES OF RATS EXPOSED TO COBALT-60 GAMMA RADIATION. Tradiff, Robert; DuBois, Kenneth P. (Chicago Univ., Ill. Air Force Radiation Lab.).

Adult, female Sprague-Dawley rats were exposed to 21.2 R and 51 R per day of cobalt-60 gamma irradiation over a 10-hour period for various lengths of time. After various total doses of radiation, the animals were sacrificed for adenosine triphosphatase measurements on the spleens and thymus glands. After repeated daily exposure to 21.2 R and 51 R per day, the adenosine triphosphatase activity of the spleens of adult and weanling rats increased to a level which was dependent upon the dose. The activity tended to level off after the first 5 days of exposure. In adult animals the adenosine triphosphatase activity of the thymus glands showed no appreciable increase after repeated exposure to gamma radiation; however the enzyme activity of the thymus glands of weanling rats increased after repeated doses of gamma radiation. (auth)

**31787** (NYO-2740-2) ANNUAL REPORT ON RESEARCH PROJECT. (Columbia Univ., New York. Radiological Research Lab.). Jan. 1, 1965. Contract AT (30-1)-2740. 232p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

Progress is reported in studies on the dosimetry of monoenergetic neutrons with energies of 3.7 and 5.7 Mev; the design of an ionization chamber for neutron dose monitoring; the testing of a tissue equivalent gas multiplication chamber for $\gamma$ response; the design of a tissue equivalent ionization chamber for use in the dosimetry of 3 Bev protons; the distribution of absorbed dose of monoenergetic neutrons in terms of the parameter Y; the correlation of dose-effects curves with energy density distribution using computer calculations; the design of a 1-in. diameter tissue equivalent spherical proportional counter; and the development of a wall-less proportional counter. Quantities and units that were developed for use in microdosimetry are summarized. The development of a low voltage x-ray generator for use in radiobiological studies is described. The design is described of a paper tape translator capable of operating the IBM 526 card punch for the transfer of digital data from a typewritten record or punched paper tape to punch cards for computer analysis. The translator uses solid-state electronics, a diode plug-in matrix switch decoder, and taper pin connections. The advantages of photomacrography for studies of growing populations of single cells and efforts to achieve an automated system in which plated cells may be photographed without trauma are discussed. Results are summarized from studies on the ultraviolet sensitivity of mutants of Escherichia coli and developing phage-host complexes; the x-ray induced reversion from auxotrophy in ultraviolet-irradiated E. coli; modification of x-ray survivals by post-irradiation exposure to light before plating; and the effects of x radiation on developing fetuses of monkeys (Rhesus macaque) and mice, with emphasis on effects on the skeleton, eyes, hematopoietic system, and nervous system. A list is included of publications reporting data from these studies. (C.H.)

**31788** (ORNL-3768(p.33-57)) CYTOLOGY AND GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: distribution of TEM-induced mutations to chromosome strands; attempts to induce mutations in Paramecium with 3,4-benzpyrene; micronuclear RNA synthesis and mutation induction; variations in cell mass and DNA content within clones of

Paramecium aurelia; age effects on mutation rate in Paramecium; ultraviolet-induced mutation and photoreactivation of mutation in Escherichia coli; ultraviolet inactivation of Bacillus subtilis (transforming DNA); further purification of the yeast photoreactivating enzyme; thermal cross section for the reaction $^{33}S(n,p)^{33}P$; production of $^{32}P$ from sulfur; change of chromosomal sensitivity in $G_1$ cells; isolation and studies of mammalian metaphase chromosomes; mitotic synchronization with 5-aminouracil; studies of the reversal of FUdR-induced DNA synthesis inhibition by thymidine; repair of chromosomal damage in seeds which are not metabolizing; comparison of the extent of the functional inactivation in x-ray-induced ad-$3^R$ and ad-$3^{IR}$ mutations in Neurospora; localization and identification of the genetic alterations in ad-$3^{IR}$ mutations induced by ICR-170; identification of the molecular part of the acridine mustard (ICR-170) important for its mutagenicity; protective effect of anoxia on x-ray-induced nuclear inactivation in Neurospora; a study of the complementation and reversion patterns exhibited by a group of ultraviolet-induced ad-3B mutants; pattern of DNA synthesis in x-autosome translocations in the mouse; radiation sensitivity in synchronized mammalian cells; radioresistant human amnion cells; amino acid sequence in $\alpha$-chain tryptic peptides of C57BL mouse hemoglobin; linkage of loci controlling serum esterase patterns and oligosyndactylism; and some properties of a non-H-2 isoantigen in RFM mice. (H.G.D.)

**31789** (ORNL-3768(p.58-63)) DROSOPHILA CYTOLOGY AND GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: the male sterility of X-autosome translocations; another difference in the behavior of Eu- and heterochromatin crossing-over; mosaic male sterility mutations in Drosophila; chemically induced mosaicism in Drosophila; revision of The Mutants of Drosophila melanogaster; correspondence between the times of DNA replication and crossing-over in the oocyte of Drosophila melanogaster; and preliminary study of reversion in the notch cistron of Drosophila. (H.G.D.)

**31790** (ORNL-3768(p.85-8)) RADIATION MICROBIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on research in: ribosomal profiles of radioresistant and radiosensitivitive E. coli; camphor-induced radioresistant mutants of E. coli K-12; mutant isolation by a D-cycloserine enrichment cycling technique; and an effect of mitomycin C on filamentous forms of E. coli. (H.G.D.)

**31791** (ORNL-3768(p.89-93)) MAMMALIAN GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: the effect of the interval between irradiation and conception on mutation frequency in female mice; strain differences in the reproductive capacity of irradiated female mice; spontaneous mutability in mice—conclusions from mosaic mutations; the pattern of DNA synthesis in X-autosome translocations in mice; and the effects of 25R x irradiation on fertility and oocyte number of 10-day-old female mice. (H.G.D.)

**31792** (ORNL-3768(p.94-8)) HUMAN CYTOGENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on research in: variations in x-radioinduced chromosomal aberrations in human leukocytes in relation to the cell cycle; electron microscope studies of c-metaphase chromosomes isolated from Chinese hamster fibroblasts; and chromosome aberrations in persons irradiated in a uranium criticality accident. (H.G.D.)

**31793** (ORNL-3768(p.109-11)) AEC-NASA SPACE BIOLOGY PROGRAM. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: the effectiveness of high-energy protons and other fast charged particles on various biological materials; the irradiation of the mouse lens with 35 Mev protons; biosatellite A preparations; spontaneous mutation frequencies in Habrobracon; and the Gemini III experiment. (H.G.D.)

**31794** (ORNL-3768(p.131-6)) CELL PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: osmotic phenomena in bacteriophages T4B and $T4BO_1$; freezing of bacteriophages T4B and $T4BO_1$; kinetics of uv-induced thymine dimerization in frozen solutions; and the effect of cooling and warming velocity on the survival of frozen and thawed yeast. (H.G.D.)

**31795** (ORNL-3768(p.181-6)) PLANT PHYSIOLOGY AND PHOTOSYNTHESIS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: heat inactivation of gibberellic acid sensitivity of lettuce seed germination; the use of radioinduced mitotic inhibitions in anatomic studies with growth regulators; metabolic control in maize embryos; the reduction of air turbulence and temperature gradients in plant growth chambers by means of small-hole diffuse walls; and photosynthesis. (H.G.D.)

**31796** (ORNL-3768(p.187-94)) BIOPHYSICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: measurements of low concentrations of free radicals; ultraviolet microbeam irradiation of the nucleus and cytoplasm of Amoeba proteus; ultraviolet photoproducts in the 5-bromouracil-substituted DNA of E. coli 15T; comparison of the uv action spectra for cell killing of E. coli; long-lived neutron activation of accelerators; properties of pyrimidine photoproducts in DNA; ultraviolet photoproducts in bacterial spores; loss of radioactivity from irradiated bacteria; and DNA transfer in bacterial conjugation. (H.G.D.)

**31797** (UCRL-11833(p.73-9)) GROWTH-HORMONE SECRETION IN TREATED AND UNTREATED ACROMEGALY. Linfoot, John A.; Greenwood, Fred C. (Lawrence Radiation Lab., Univ. of California, Berkeley).

A sensitive radio-immunoelectrophoretic assay was used to determine the effects of heavy particles delivered to the sella turcica on levels of circulating growth-hormone in a series of acromegalic patients. In 14 untreated patients, the plasma-growth-hormone (HGH) level ranged from 9 to 99 mμg/ml with a mean of 40.8 mμg/ml, whereas the mean was 6.8 mμg/ml in 16 patients who had received heavy-particle therapy. The changes in HGH during insulin- and glucose-tolerance tests in two acromegalic patients, who differed clinically as well as metabolically, are also described. (auth)

**31798** (UCRL-11833(p.80-94)) EFFECT OF HEAVY PARTICLES ON THE PROLIFERATIVE CAPACITY OF ASCITES TUMOR CELLS (LYMPHOMA) GROWN IN VIVO. Schmidlin, Yolanda; Lawrence, John H.; Sillesen, Karen; Welch, Graeme; Lyman, John (Lawrence Radiation Lab., Univ. of California, Berkeley).

The effects of varying densities of ionizing radiation (including x rays, 35- to 45-Mev protons, or 40 Mev alpha particles) on ascites tumor cells irradiated in vivo or in vitro were studied. Whole-body irradiations were performed in air or under anoxic or hypoxic conditions. Irradiated cells were injected into living mice to test their proliferative capacity. The radiosensitivity of lymphoma-ascitic-tumor cells to 200-kv x rays (LET 1.5 to 3 kev/μ) was like that of anoxic cells whether the animal was killed a few minutes prior to irradiation, was breathing air during irradiation or was breathing pure oxygen during irradiation. The oxygen enhancement ratio for 200-kv x rays in the in vitro experiments was two; however, when using whole-body irradiation of the animal carrying the cells it was lower, probably because of the long time interval between the intraperitoneal injection of $H_2O_2$ and the completion of irradiation and thus the incomplete oxygenation of the cells. The RBE of 35- to 45-Mev protons approaches one when using both the plateau portion (LET 1.5 to 2 kev/μ) and certain portions of the Bragg-peak (LET 3 to 7 kev/μ) of the beam. In the in vitro experiments the oxygen enhancement ratios for both the plateau and peak portions (low LET) of the 35- to 45-Mev proton beam are smaller than that for the 200-kv x rays. The RBE of 40-Mev alpha

particles (LET 18.6 kev/$\mu$) was approximately one. (H.G.D.)

**31799** (UCRL-11833(p.121-33)) BLOCKAGE OF PUPILLODILATION WITH CYCLOTRON-ACCELERATED ALPHA PARTICLES. Gaffey, Cornelius T.; Kelley, Anne K. (Lawrence Radiation Lab., Univ. of California, Berkeley).

Contact with the pupillodilation center (nucleus perifornicalis of the hypothalmus) was made by insertion of bipolar electrodes through burr holes in the skull of cats. The leads from the left and right hemispheres were connected to a radio socket that was secured to the skull of an animal. Electrical stimulation of the pupillodilation center was made through the head socket of alert cats. The Lawrence Radiation Laboratory's 184-inch synchrocyclotron served as a source of 910-MeV alpha particles. By a cross-fire-technique the pupillodilation center of the cat's brain was irradiated. This was accomplished by aligning the head of the cat in the path of the cyclotron beam with X rays so that the tip of the implanted electrode was both in the center of the high-energy beam and at the focus of a mechanical rotator. Head translations about this focus of rotation concentrated irradiation in a discrete, spherical volume the diameter of the beam's aperture. Since the implanted electrode was in the center of this irradiated volume, the time-course for the blockage of pupillodilation could be studied as a function of the delivered dose of alpha particles. It was found that the action of electrical stimulation on the pupillodilation center could be inhibited immediately and irreversibly by 100,000 rads. Below 8,000 rads there was no detectable effect on the pupillodilation center even after seven months. In doses less than 32,000 rads the threshold voltage necessary to produce pupillodilation followed a biphasic pattern. A decrease in the threshold voltage was coincident with the appearance of pupil-size imbalance in the absence of electrical stimulation. (auth)

**31800** (UR-663) PLATELET SIZE DISTRIBUTION FOLLOWING X IRRADIATION. Spertzel, R. O.; Bucci, T. J.; Ingram, M. (Rochester Univ., N. Y. Atomic Energy Project). Jan. 29, 1965. Contract W-7405-eng-49. 16p. (CONF-19-5). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 2nd International Congress of Radiation Research, Harrogate, Eng., Aug. 1962.

Routine microscopic examination of stained blood films indicate that platelet size becomes irregular in dogs during recovery from single large x-ray doses, and in men receiving low-level exposures over long periods. In dogs, the abnormal size distribution is apparent even after the animals have recovered from the acute effects of exposure. The Coulter Counter Model B, equipped with a Particle Size Distribution Plotter was used to evaluate platelet size distribution quantitatively. A differential sedimentation method using polyvinylpyrolidone (pvp) was employed to obtain suspensions of platelets nearly free of contaminating red and white cells. In order to evaluate changes in platelet volume distribution following radiation-induced thrombocytopenia, it was first necessary to establish the range of variability of platelet volume distribution over a period of many weeks in the unirradiated animal, and to determine the normal range of volumes among a representative group of non-irradiated dogs. For this purpose 8 male and 10 female normal pure-bred Beagle dogs were studied. Platelets from 10 dogs exposed to 450 R x radiation were studied one day prior to exposure and on the first, fourth, and seventh post-exposure days. During these first 7 post-exposure days, histograms of platelet volumes showed similar changes in all dogs, characterized by a very slight progressive decrease in the number of larger platelets. On post-exposure days 11, 14 and 21 the number of circulating platelets was too low to provide sufficient cells to graph without resorting to larger blood samples or altered platelet concentration procedures. During this period, chamber counts ranged from 0 to approximately 15,000/mm$^3$ and graphs were obtained only when counts rose to approximately 20,000 mm$^3$. By the 28th post-exposure day, seven dogs had sufficient platelets to graph and on the 35th–46th day the remaining dogs could be studied. Consecutive sampling of the same animal resulted in strikingly consistent histograms but there was a marked difference between the histograms of male dogs and female dogs, while variation from dog to dog within the same sex was slight. (C.H.)

**31801** (USNRDL-TR-840) ENZYME ACTIVITY CHANGES AND CELL VOLUME DISTRIBUTION IN MOUSE THYMUS AFTER X IRRADIATION. Greenberg, L. J.; Cole, L. J.; Martin, R. L. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 2, 1965. 17p.

Cell suspensions were prepared from the thymuses of 2-month old $LAF_1$ female mice at various time intervals after whole-body exposure to a single sublethal dose of x rays (600 rad of 250 kvp x rays; dose-rate 30 rad per minute) and from nonirradiated controls. Cell aliquots were subjected to volume distribution analysis (Coulter Counter) and assayed fluorimetrically for alkaline phosphatase, alanyl amidase, and leucyl amidase activities, which were expressed as moles of fluorogen $\times 10^{-11}$/cell/hour. Increases in the activities of all enzymes were evident one day postirradiation, attained a maximum (7 to 10-fold increase) between days 5 and 7, and returned to control levels by day 11. Cell volume distribution analysis suggests that these increases are not merely a reflection of shifts in cell population (i.e., the removal of cells without activity) but represent an increase in the activity per cell, an increase in the number of cells with activity, or both situations. (auth)

**31802** (USNRDL-TR-841) EFFECTS OF TOTAL-BODY X-IRRADIATION ON PERITONEAL CELLS OF MICE. Kornfeld, L.; Greenman, V. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 20, 1965. 26p.

Peritoneal cells of normal and irradiated $LAF_1$ mice which had not been pretreated with peritoneal irritants were studied by phase-contrast microscopy and in stained smears. The average number of leukocytes recovered per normal mouse was $7.4 \times 10^6$. Approximately 95% of the cells were mononuclear; of these, macrophages comprised 29% ($2.2 \times 10^6$), small and medium lymphocytes 71% (as determined by phase-contrast). One day after whole-body exposure to 690 R ($LD_{30/30}$) or 720 R ($LD_{50/30}$), the mean leukocyte count was $3.4 \times 10^6$, macrophages accounted for 65% ($2.2 \times 10^6$) of the cells. From 3 to 21 days postirradiation, cell counts gradually decreased further to $1.5 \times 10^6$. Macrophages decreased at the same rate; they constituted approximately 70% of the cells during this period. Thereafter, the number of leukocytes increased and reached normal levels by the 12th week postirradiation. When suspensions of viable Escherichia coli or Staphylococcus aureus were injected 30 minutes before sacrifice, the macrophages of both normal and irradiated mice contained large numbers of microorganisms, but 30 minutes after injection of bacteria or E. coli lipopolysaccharide (10 $\mu$g) into normal mice, the number of cells in peritoneal washings was not altered. However, after injection of these agents into irradiated mice, total cell counts were significantly lower than in uninjected or diluent-injected mice. (auth)

**31803** (UCRL-Trans-1225) CRITERIA FOR RADIATION SAFETY OF SPACE FLIGHTS OF LONG DURATION. Grigor'ev, Yu. G.; Kovalev, E. E.; Lebendinskii, A. V.; Nefedov, Yu. G.; Vysotskii, V. G.; Ryzhov, N. J.; Markelov, B. A.; Smirennyi, L. N.; Dudkin, V. E.; Derbeneva, N. N. Translated by M. Kassatkin (Univ. of California Lawrence Radiation Lab., Berkeley), from "2nd International Symposium on Basic Environmental Problems of Man in Space," Paris, June 14–18, 1965. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $2.60(fs), $0.89(mf) JCL.

Available data on radiation protection during long-duration space flights are reviewed. It is suggested that radiation protection should include general protection of the compartments, radiation shelter, local protection,

radiation dosimetry aboard the ship, individual monitoring, chemical protection against radiation injuries, methods of therapy in the event of radiation injury, and ground service for radiation protection. It is pointed out that the biological effect of each type of ionizing radiation depends on the amount of ionization losses and on the dose and length of exposure to radiation. The basic sources of radiation in cosmic space include galactic cosmic radiation, the inner and outer radiation belts of the earth, the artificial radiation belt of the earth, and solar corpuscular radiation during chromospheric flares of the sun. The biological effects of radiation from each source are discussed. It is concluded that galactic cosmic radiation, consisting basically of protons, $\alpha$ particles, and light nuclei, will present serious danger to cosmonauts during flights of long duration. Corpuscular radiation of solar flares consists basically of protons and $\alpha$ particles with the proton spectrum containing particles with energies of from several Mev to tens of Bev. During periods of maximum solar activity about 5 to 13 flares of low intensity occur in a year and a period of solar activity is expected in 1969 and 1970. Shielding problems are considered briefly. Data on the relative biological effects of protons with energies of 126 to 510 Mev in dogs, mice, and rats after single or multiple exposures are discussed. Criteria are included for radiation safety during a 15-day flight to the moon and back to Earth based on existing knowledge of the biological effects of ionizing radiation and allowing for a certain acceptable risk factor. (C.H.)

**31804** LATE EFFECTS OF SMALL DOSES OF IONIZING RADIATIONS. Rubio, Fidel Fernandez. Acta Iber. Radiol. Cancerol., 18: 145-52(Apr.-June 1963). (In Spanish)

Various kinds of evidence indicating that small, repeated doses of ionizing radiation may have a detrimental cumulative effect are compiled. Early evidence indicated that doses as low as one R/week could produce detectable effects if repeated long enough. International commissions concerned with radioprotection have reduced the maximum acceptable dose from 300 mR/week in 1950 to 100 mR/week in 1953. Examination of the evidence by organ systems shows that the eyes may show increased incidence of cataracts at doses of 1 R/day; skin may show changes after 0.5 R/day and cancer development after 5 R/day; hematopoietic tissue is damaged by as little as 0.002 R/day as seen by hematologic changes, or 5 R/day as seen by leukemogenesis; and gonads are affected by 0.1 R/day (decreased numbers of spermatocytes) up to 5 R/day (total sterility). Life-shortening effects of irradiation in animals are evident after single doses of 300 rem, and continuous irradiation to accumulated doses of 500 to 700 R has been found to increase mortality 10 to 25%. A single whole-body dose of 80% of the $LD_{30/30}$ shortens life by about 20% in rats. Evidence relating to decreased longevity, and especially more frequent deaths from leukemia, in radiologists (as compared with other physicians) and among exposed Japanese atomic bombing survivors is reviewed. Children receiving radiotherapy for enlarged thymus and patients with ankylosing spondylitis exposed to therapeutic x rays have also demonstrated the carcinogenic and leukemogenic effects of radiation. The concept of a threshold dose of radiation in relation to these late effects is discussed. (BBB)

**31805** SOME ASPECTS OF THE HEMOSTATIC MECHANISM IN DOGS FOLLOWED INTERNAL IRRADIATION WITH RADIOACTIVE GOLD COLLOIDS. Karanfilski, B. T.; Tadzer, I. S. Acta Med. Iugoslav., 18: 46-57(1964).

Radioactive gold colloids were given in massive doses of 25,000 to 50,000 reps administered to the liver of 13 dogs. Acute and chronic effects upon blood clotting were produced. Acute radiation effects included: plasma clotting factors, including the factors with a fast metabolic rate depending on the continuous regeneration by the liver, remained unchanged in the acute radiation phase. This gives evidence of a remarkable radioresistance of the liver. Several days after irradiation platelets decreased substantially in all animals, which markedly affected the prothrombin consumption test and narrowed the maximal amplitude of thromboelastograms. This effect may be considered as a bone-marrow insufficiency due not only to the beta irradiation by colloid particles in loco but also to the distant effect of the whole body gamma irradiation. Surviving animals gradually recovered their thrombopoiesis. The animals that died of acute radiation showed a significant depression of plasma clotting factors only in the late stages. Chronic radiation effects included cirrhosis of the liver, ascites, and hypoproteinaemia. The platelet count in this phase returned to subnormal and normal values. The haemostatic mechanism presented changes in a complex manner: substantial depression of all the factors involved in the prothrombin activation, resistance of some factors, and a suggestive evidence of a circulating anticoagulant with an immediate effect of the antithrombin type. (TCO)

**31806** RADIATION STUDIES ON THE RETINA. Hamberger, A.; Rosengren, B. O. H.; Tengroth, B. (Univ. of Goteburg). Acta Ophthalmol., 42: 951-6 (1964).

Changes in the electroretinogram (ERG) after irradiation would be of great interest clinically, since it is a sensitive method that can be used repeatedly in patients. The ability to follow the ERG in patients treated with ionizing radiation would give the clinician an idea of its systematic effect; however, the nature of the ERG is still obscure, and it is not known exactly in which part or layer of the retina the different ERG components originate. As the cell elements in the retina differ from each other in radioresponsiveness, changes in ERG should differ at different dose levels. Using a technique, by which small and reversible changes can be demonstrated, the authors attempted to correlate small changes in ERG with small changes in the different cell elements and thus provide more detailed information concerning the nature of the ERG. Experiments were conducted by irradiating the right eye of white rabbits with a 2-cm dia beam of 200-kv x rays. A dose of 3000 R was given during 15 min and two animals were subjected to 6000 R during 30 min. Immediately after irradiation the animals were put in a dark box to achieve the necessary dark adaptation prior to making an ERG recording. No physical sign of radiation sickness was observed. The ERG results, expressed as the amplitude of the b wave, varied between 350 and 250 $\mu$v. No difference was observed between the irradiated eye and the control eye in the 3000-R groups investigated either 2 hr or 7 days after irradiation. In the 6000-R group there was a definite difference; the b-wave did not exceed 100 $\mu$v in the irradiated eye. The results of assays of succinoxidase activity on individual retinal ganglion cells are also reported in two groups of animals. In the first group (3000 R, 2 to 3 hr before the experiment) there was a definite increase in succinoxidase activity of the exposed eye. In the second group (irradiated one week before) no difference between the treated and control was observed. No cells from the 6000-R group were analyzed. Previous quantitative studies on retinal ganglion cells performed after light stimulation have established that moderate stimulation rapidly induces an increase at several chemical components of the cells. Moreover, electron microscopic studies of the retinal ganglion cells about one hour after a light stimulus demonstrate considerable increase in the mitochondrial size. Thus the present results demonstrating a marked increase in succinoxidase activity in the ganglion cells are in accordance with those after light stimulation. The return of succinoxidase activity to control values one week later shows that no irreversible damage is caused. The effect could either be due to a brief, rapid stimulation of synthesis of enzymes or to structural derangement of the mitochondria and subsequent activation of enzyme activity. (BBB)

**31807** SURVIVAL AND MUTATION IN MYCOBACTERIUM BOVIS (BCG) IRRADIATED WITH X-RAY IN DRY AND WET STATES. Tsukamura, M.; Guidi, V.; Tarallo, L. (Universita, Naples). Acta Tuberc. Scand., 45: 145-8 (1964).

Ionizing irradiation shows two effects, a direct and indirect effect. Irradiation of dried and wet Escherichia coli previously showed that survival of the organism was less in a wet state. For comparison of the direct and indirect effects of x rays the present experiments used the lyophilized BCG vaccine. It was expected that the action of x rays on lyophilized bacilli would be mainly due to the direct effect and that on suspended bacilli to both the direct and indirect effects. Another purpose of the study was to observe the mutagenic effect of x irradiation on M. bovis. The doses of 200-kv x rays used varied from 50 to 200 kR. X irradiation caused killing (loss of colony-forming capacity) of BCG mycobacteria in dried state (in lyophilized state), showing a single-hit type curve. This organism presumably has a single haploid nucleus. X irradiation caused an increase of mutation frequency in dried cells. The mutation frequency increased with increase of the dose up to 100,000-R irradiation, but, when irradiated with a dose of 200,000 R, it decreased slightly from the 100,000-R value. It is suggested that mutation is caused by the direct effect of x irradiation and is the resultant of complex events. When the bacterial cells were irradiated in wet state (in suspension), killing and mutation occurred more markedly; therefore, it is suggested that indirect effects play an important role for killing and mutation. (BBB)

**31808** CYTOGENETIC STUDIES IN CHRONIC MYELOID LEUKEMIA. Court Brown, W. M.; Tough, Ishbel M. (Western General Hospital, Edinburgh). Advan. Cancer Res., 7: 351-81(1963).

A review is presented of chromosome aberrations in chronic myeloid leukemia, with emphasis on the significance of the Philadelphia ($Ph^1$) chromosome and the possible role of ionizing radiation in the induction of this disease. There is good evidence that, like acute leukemia but unlike chronic lymphatic leukemia, chronic myeloid leukemia can be induced by exposure to heavy doses of ionizing radiations, but there is no evidence as to whether doses of radiations comparable to or less than those received in medical diagnostic radiology are leukemogenic. Among the Hiroshima survivors there was a considerable increase in the disease among those exposed at less than 2000 m from the hypocenter of the explosion. The total number of cases was actually greater than the total cases of acute leukemia, a finding in sharp contrast to observations on the increased mortality from leukemia among patients therapeutically irradiated with x rays for ankylosing spondylitis. Among the latter subjects the total of cases of acute leukemia considerably exceeded those of chronic myeloid leukemia. The Edinburgh group have done chromosome studies on cultures of fibroblasts from 12 patients with chronic myeloid leukemia. In all the patients $Ph^1$ + ve cells were present in blood cultures, but in none was the abnormal chromosome found in fibroblasts. It is concluded that the $Ph^1$ chromosome arises de novo in hematopoietic cells, and that, except possibly in the rare instances of chronic myeloid leukemia in young children, the chromosome has its origin during postnatal life. The $Ph^1$ chromosome must arise through the loss of material from the long arm of a no. 21. Whether a deletion alone is involved, or whether deleted material is translocated onto another chromosome, is not known. If a translocation does occur, the amount of material involved is so small that its attachment to a larger chromosome is unlikely to be detected with current techniques. Data on the effect of x-ray therapy to the spleen show that the frequency of $Ph^1$ + ve cells in the blood cultures declines as the total white cell count falls, until such cells are no longer found. It is apparent, however, that the disappearance of $Ph^1$ + ve cells from the blood cultures is not reflected in their disappearance from the bone marrow. Thus in one case that at the end of a course of splenic irradiation no $Ph^1$ + ve cells were present in a blood culture, at a time when the great majority of scorable cells in a marrow culture were $Ph^1$ + ve. After treatment with busulfan (Myleran), $Ph^1$ + ve cells were the only cells seen in a direct marrow preparation at a time when they were no longer found in a blood culture. Among 25 patients in the chronic phase of the disease, who were first investigated after treatment and for whom adequate preparations were available, $Ph^1$ + ve cells were identified in 20 cases; 19 of these had $Ph^1$ + ve cells in blood cultures, while in the remaining case a blood culture was negative but a direct marrow examination showed the abnormal chromosome. Of the 5 patients who were $Ph^1$ – ve on blood culture, 4 were in remission and 1 was in relapse following x-ray therapy. Patients may be $Ph^1$ – ve on blood culture but $Ph^1$ + ve on study of their marrow cells. One such untreated case has been noted, and several cases were studied either during or after treatment. Treatment, whether by x-ray therapy or chemotherapy, can lead to a disappearance of $Ph^1$ + ve cells from a blood culture at a time when they continue to be demonstrable in marrow. It is not yet certain that radiation-induced examples of chronic myeloid leukemia demonstrate the $Ph^1$ chromosome, and it is of fundamental importance to know if this is the case. In assessing human leukemias, it is not possible to assert positively that a given case of leukemia is radiation-induced simply because the individual was exposed to radiation some time prior to the clinical manifestation of leukemia. It is possible, however, to make some assessment in any given case of whether there is an appreciable probability of the disease being radiation-induced on the basis of the radiation dose, the volume of tissue irradiated, the type of leukemia, and the latent period between exposure and the clinical onset of symptoms. Thus a patient developing either acute leukemia or chronic myeloid leukemia between 4 and 7 years after exposure to an extensive radiotherapeutic procedure would be regarded as having a high probability of the disease being radiation-induced. Many patients with a history of previous radiotherapy have been examined by the Philadelphia and Edinburgh groups. With one exception, none of these cases are convincing examples of radiation-induced leukemias, usually on the grounds of the latent period being either too short or too long. The single exception is a case of chronic myeloid leukemia in a subject who had had repeated spinal irradiation for ankylosing spondylitis. In this instance several blood cultures have been $Ph^1$ – ve, but the patient, when examined, has always been in remission following chemotherapy, and it has not yet been possible to study marrow cells. In these circumstances, therefore, no decision is possible at present on whether radiation-induced cases of chronic myeloid leukemia are $Ph^1$ + ve. (BBB)

**31809** SIMILARITIES AND CONTRASTS BETWEEN RADIATION AND TIME PATHOLOGY. Casarett, George W. (Univ. of Rochester, N. Y.). Advan. Gerontol. Res., 1: 109-23(1964).

This review, citing 180 references, of actuarial, pathological, histopathological, and physiological changes following irradiation, in comparison with the manifestations of normal aging, points out the strong qualitative resemblance between the permanent and late effects of life-shortening total-body irradiation and the manifestations of premature aging. However, qualitative differences seem to exist and quantitative factors are not always equivalent or proportional. In normal aging of mammals, the most universal and progressive deleterious change seen at the histopathological level is an increase in the histohematic barrier, i.e., the connective-tissue barrier between blood and the dependent parenchymal cells through which $O_2$, $CO_2$, nutrients, and wastes must pass to and from the cells and the blood. The increase in this barrier is associated with decreased functional effectiveness of the barrier in terms of selective diffusion or transport of nutrients and wastes across it. The progressive increase in degree of these processes with increasing age eventually reaches a point at which the functional inadequacy involved, in terms of support of dependent parenchymal cells, causes a gradual loss of these cells at varying degrees and rates in various

tissues and organs, with resultant progressive decrement in parenchymal function, increased susceptibility to infectious disease and stress, development of degenerative disease and neoplasms, and ultimate death. Total-body irradiation in life-shortening doses advances this increase in the histohematic barrier and its sequential consequences to variable degrees in various tissues and organs, the degree depending considerably upon the sensitivity of the parenchymal cells to the destructive action of radiation. In irradiated animals, the nonspecific damage of the endothelium of the fine vasculature and interstitial fibroblasts, by direct, indirect, or abscopal mechanisms, is the change of greatest importance, among the early radiation injuries, in the development of an increase in the histohematic barrier and in the eventual development of the premature tissue fibroatrophy of radiological aging and its sequential consequences. These changes increase progressively with time in the irradiated tissues as they do in nonirradiated tissues, but not necessarily in precisely proportional or equivalent increments, and they remain temporally advanced in degree in the irradiated tissues. As these progressive changes gradually reduce the capacity of the vasculoconnective tissues to support the full complement of parenchymal cells, these cells suffer increasing impairment of functional capacity and decrease in number. The loss of parenchymal cells occurs earlier in the irradiated tissues than in the nonirradiated tissues, according to the advanced changes in the histohematic barrier. Replacement fibrosis then occurs, with an increase in interstitial mesenchymal elements and fibrous tissue and a further reduction of fine vasculature secondary to the loss of parenchymal cells, further increasing the histohematic barrier. In radiological aging, and aging as well, it is probable that nuclear damage of cells is more important than direct effects on connective-tissue matrices. For example, injury or death of fibroblasts may cause decreased synthesis of the ground substance and an increased density of collagen. In tissues containing radiation-resistant reverting postmitotic parenchymal cells (such as liver and kidney and many other epithelial glands) and tissues containing the irreplaceable, radiation-resistant, fixed postmitotic parenchymal cells (such as muscle and brain) the early radiation destruction of considerable numbers of the parenchymal cells in direct, or indirect, fashion requires relatively large doses, doses which also cause marked damage of vasculoconnective tissues. Consequently, early destruction of considerable numbers of these parenchymal cells is not seen with total-body irradiation in the sublethal dose range, but only with more intensive localized, or generalized, irradiation. However, with sublethal irradiation of the whole body, the aging types of changes in the vasculoconnective tissue may be advanced temporally, and the parenchyma, although not appreciably damaged histopathologically in earlier phases, may show a precocious loss of parenchyma in the later phase of age-involution secondary to these changes. With increasing doses in localized exposures, the temporal advancement of these processes is progressively greater. (BBB)

**31810** INTEGRATED HUMAN RESEARCH AND AEROSPACE MEDICINE. Clemedson, Carl-Johan (Univ. of Gothenberg, Sweden). Aerospace Med., 35: 511-18(June 1964).

Some areas of research in aerospace medicine are reviewed, including recent developments in the field of ionizing radiations. Since the space ambient radiations constitute a very important part of the space environment, research on the effects of these radiations on the human body and the establishment of radiation safety limits are essential for the fulfillment of future aerospace missions. The primary sources of radiation hazards to man in space are heavy primary cosmic particles, geomagnetically trapped corpuscular radiations, and solar flare protons. Physical data now available are not adequate for the estimation of ranges of radiation dose rates and integral doses to be expected, especially as applied to intensities and temporal and spectral variations of solar flare protons. Nor are there enough data on the effects of ionizing radiation, especially at low intensity, on man. As an example, it is mentioned that it is not known exactly why the difference in median lethal dose varies over a range of not less than about $10^5$ between the most sensitive and the most resistant forms of life which have so far been investigated, or why even in the same organism the $LD_{50}$ for the most radioresistant cells may be $10^4$ to $10^5$ times higher than that for the most sensitive cells. Radiation hazards, particularly from solar flares and from heavy primaries, present a serious problem and for long voyages in space it is anticipated that shielding must be applied. The spectral distribution of the space radiations and the biological effects of both primary and secondary radiation must be known to avoid unnecessary shielding. The radiation exposure that can be anticipated in space will not be delivered at a constant dose rate but in a complex pattern. Most likely, astronauts will be exposed to occasional acute doses, sometimes quite large ones, of limited duration and delivered at a changing dose rate, as in penetration of the Van Allen belts and during strong solar flare events. Thus, many factors inherent in space exposure conditions such as nature and quality of the radiations, RBE, dose rate, depth dose, and body regions exposed will modify the dose-response curve. It is suggested that at the median lethal dose for man, 400 to 500 rad of whole-body irradiation, only about 0.5% of the body's reproducing cells still are able to multiply. However, dose-effect relations for acute lethality in man are known only roughly, and these relations for late effects in man are even more uncertain. There is a pressing need for realistic radiation safety criteria for the future manned space flights; the recommendations of the International Commission on Radiological Protection (ICRP) do not necessarily apply, at least not to early manned space missions, since for specific situations a number of factors should be taken into consideration, for instance the number of individuals involved, length of the working career, and probable risk vs potential gain. Since elimination of all probability of risk from early or late radiation effects appears impractical, or even impossible, the possibilities of chemical and biological protection of man against the effects of radiation exposure should be given due attention, it is concluded. (BBB)

**31811** RADIATION AND CONGENITAL MALFORMATIONS. Brill, A. B.; Forgotson, E. H. (Vanderbilt Univ., Nashville). Am. J. Obstet. Gynecol., 90: 1149-68(Dec. 1, 1964).

The prenatal effects of ionizing radiation, particularly with respect to the human embryo and fetus are reviewed, and some medicolegal implications considered. In general, it is noted that at a given gestational stage on increasing the dose there is: (1) an increase in incidence of abnormalities; (2) an increase in the severity of the lesions produced; and (3) effects similar to those produced at some sensitive stages by lower doses. This can be attributed to the increased probability of inducing critical physical-chemical changes in the involved cells, which in part may reflect a diminution in the effectiveness of repair processes. Known effects of radiation on chromosomes are examined, and known chromosome anomalies, such as found in mongolism and some types of leukemia, are discussed in relation to their induction by radiation. The actions of ionizing radiation and other damaging agents on the developing embryo and fetus are probably similar at the molecular and cellular levels. In addition to effects on DNA replication and chromosomes, developmental effects may reflect more subtle intracellular metabolic alterations possibly involving energy transfer mechanisms. The markers of postzygotic prenatal effects are not amenable to clear distinction yet and cannot be quantified. However, they are probably qualitatively similar to the markers for adult pre- or postzygotic damage. The high susceptibility of actively dividing embryonic tissue in contrast to adult tissues reflects both the radiation sensitivity of cells undergoing rapid mitosis and the intense amplification of induced de-

fects during fetal development. Irradiation preimplantation, in general, is not followed by morphological abnormalities, alterations in birth or post-weaning weights, fertility, or life-span. The all-or-none response to radiation, with either an apparently normal offspring or a dead fetus, suggests that mammalian blastomeres are totipotent, and that loss of a cell at this stage can be compensated for, at least in part, by remaining cells. At doses above 100 R, prenatal mortality is generally increased in the earliest part of the period of organogenesis but less so than is noted when the radiation is given in the earlier stages of embryogenesis. Numerous abnormalities of mammalian embryos following irradiation during the period of major organogenesis have been reported, and the data suggest that there is a precise schedule by which the organism develops and that injuries at specific times have predictable sequelae. Presumably, regions with the highest relative growth rate, DNA replication, cell division, and differentiation are maximally radiosensitive at those times when these processes are most active. Critical periods for the induction of almost all abnormalities are relatively short, and can be extended by raising the dose, indicating that a certain degree of sensitivity exists at stages other than the most critical one. On the other hand, the complexity developmental processes make it possible to assign a single precise time at which radiation induces each of the major anomalies. In general, central nervous system anomalies are induced early, followed by effects on the eye, vertebral column and thorax, visceral skeleton, and viscera, and lastly by anomalies of the appendicular skeleton, with considerable overlap. Much research and public attention has been directed to the possible hazards of exposures to diagnostic radiation especially during pregnancy. However, no evidence now exists which links diagnostic radiography during pregnancy with the birth of malformed children. It is concluded that, unless definitely indicated by prudent medical considerations, radiation and other potentially hazardous exposures particularly to larger doses should be restricted to the first 14 days following the beginning of a normal menstrual period to reduce the probability of damaging a potentially highly sensitive unsuspected developing embryo. 98 references. (BBB)

**31812** BIOLOGIC PROPERTIES AND CHARACTERISTICS OF ANAPLASMA MARGINALE: EFFECTS OF IONIZING RADIATION ON INFECTIVITY OF WHOLE BLOOD PREPARATIONS. Gough, B. J.; Dimopoullos, George T. (Louisiana State Univ., Baton Rouge). Am. J. Vet. Res., 26: 246-9(Mar. 1965).

To determine the effects of ionizing radiation upon the infectivity of A. marginale in whole blood, infected blood samples with about 50% of the erythrocytes containing Anaplasma bodies were subjected to $^{60}Co$ irradiation at a rate of 3000 R/min to doses up to 1.6 MR. Irradiation resulted in marked alterations in the incubation period of the disease and infectivity of the organism for splenectomized calves. Blood samples exposed to doses ranging from 3000 to 79,000 R were infectious for splenectomized calves. In all infected calves, the incubation period increased as the exposure dose of radiation increased. Samples exposed to 90,000 R or more were not infectious for the calves. When susceptibility was challenged after 90 days, all calves became infected within 15 days. In control calves inoculated with untreated infected blood, incubation periods were 9 to 13 days. Calves which became infected from irradiated blood did not show apparent differences in the development of clinical anaplasmosis. The degree of infection and erythrocyte counts resemble that of challenged and control animals infected with unirradiated blood. Morphologic aberrations of the organism were not detected in blood smears stained with Giemsa's stain. Some irradiated blood samples showed hemolysis, and preparations exposed to 810,000 R or more were completely hemolyzed. Darkening of the blood samples also occurred above 90,000 R. Ionizing radiation presumably hemolyzes erythrocytes directly by increasing the permeability of the erythrocytic membrane. This hemolytic action is not due to the production of lysing substances in the plasma. Comparative radiosensitivity of microörganisms is discussed. Bacteria are inactivated by irradiation levels between 90,000 and 150,000 R, whereas viruses and rickettsia require levels between 500,000 and 2,000,000 R for inactivation. Protozoa can be inactivated at irradiation levels of 50,000 to 250,000 R. (BBB)

**31813** THE ANTITUMOR FACTORS IN MICE INNER RADIATED WITH $Sr^{90}$ AND $Cs^{137}$ FOR MANY GENERATIONS. Nishio, Kazuo; Megumi, Tsunco (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 99-101(Mar. 1965).

Homogenate of intestine from mice administered water containing 0.001 microcurie of $Sr^{90}$ and 0.004 microcuries of $^{137}Cs$ through generations can prolong fairly well the survival of mice transplanted with Ehrlich ascites tumor. (auth)

**31814** THE PREPARATION OF LEVI'S ANTIPLASMA AGAINST EHRLICH ASCITES TUMOR IN MICE ADMINISTERED WITH $Sr^{90}$ AND $Cs^{137}$. Megumi, Tsunco; Nishio, Kazuo (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 102-3(Mar. 1965).

Levi's method for antitumor serum from rabbits was modified to be applied to mice. Antitumor blood plasma prepared from mice administered $^{90}Sr$ and $^{137}Cs$ through generations could prolong the survival of mice transplanted with Ehrlich ascites tumor by 6 days compared with 12 days for control animals. (auth)

**31815** CORRELATION BETWEEN THE PLASMA LEVEL OF FREE CORTICOSTERONE AND THE IN VITRO ADRENAL ACTIVITY IN THE RAT. Eechaute, W.; Lacroix, E.; Leusen, I. (Universite, Ghent). Arch. Intern. Physiol. Biochim., 71: 528-33(Aug. 1963). (In French)

Attempts were made to correlate the plasma levels of corticosterone with the production of the hormone in vitro under various conditions. The plasma levels varied between 2 and 42 μg/100 ml under control or stress conditions, 3.4 to 41.5 in hypertensive rats, 2.5 to 50 for rats treated with reserpine or tetrabenazine, and 3.5 to 39.0 for irradiated rats. When the production of corticosterone by two adrenal glands from the same rats was measured in vitro, the corresponding values were 0.4 to 6.5, 0.5 to 6.2, 1.0 to 7.2, and 0.8 to 6.3 μg. The correlation coefficients (r) for the four groups were 0.78, 0.94, 0.78, and 0.88. No details of the irradiation methods are given. (BBB)

**31816** ON THE PROBLEM OF SPECIFIC AND NONSPECIFIC REACTIONS OF THE SKIN TO X RAYS. Wagener, H. H. (Universitaets-Klinik, Basel). Arch. Klin. Expti. Dermatol., 216: 319-24(1963). (In German)

Relation of the wheal resorption time to u-v and x irradiation was studied. Initially, exposure to uv irradiation had no effects on the conductivity of adult rabbit skin. The conductivity decreased slightly after exposure to a dose of 1000 R. When areas of the skin that had been made acutely edematous from previous uv exposure were irradiated with 8800 R, the conductivity decrease observed was similar to that found in x-irradiated normal skin. The skin areas that had been made erythematous with nicotinic acid butoxyethyl ester or with acetylcholine were exposed to 8800 R of x irradiation, similar results were obtained. The lack of any additional effect on skin conductivity produced by the x irradiation suggested that its primary effect on skin capillaries was similar to that produced by other erythematogenic agents. However, it was not possible to ascertain whether the primary effects of x irradiation were exerted on the cellular elements of the capillaries or on the interstitial tissue, or both. (BBB)

**31817** TUMOR INCIDENCE IN A-STRAIN MICE. PART I. AFTER INTERMITTENT RADIATION. Duhig, James T. (New England Deaconess Hospital, Boston). Arch. Pathol., 79: 177-84(Feb. 1964).

The incidence of benign and malignant tumors in A-strain mice dying after exposure to various total doses of intermittent whole-body irradiation was investigated. Pulmonary adenomas and lymphomas were the only neoplasms seen frequently. Correction of the incidences of these two tumors for intercurrent deaths did not result in any marked alteration in the relationship between incidence and dose seen in the crude figures. (auth)

**31818** THE DESTRUCTION OF MEDULLARY CENTERS OF THE RABBIT BY A SINGLE HIGH-LEVEL X IRRADIATION. Decker, K.; Kugler, J. (Universitaet, Munich). Arch. Psychiat. Nervenkrankh., 204: 472-83 (Sept. 18, 1963). (In German)

The region of the medulla oblongata of rabbits was x irradiated at rates up to 7000 R/hr. Respiration became impaired and the animals died of hypoxia. The survival times of rabbits irradiated with single doses of 5000 to 40000 R was reduced from 3 weeks at the lower dosage to only 24 hr at the higher dosage. At dosages over 30000 R no recovery was observed after irradiation. In 14 animals that were irradiated up to the time when cardiac activity ceased, the dosage given was between 49000 and 68000 R, with an average of 55000 R. As shown by encephalographic measurements, irradiation up to 20000 R produced only minor changes. A second phase, with decreased reflex activity, occurred between 20000 and 40000 R. The wave amplitudes of the encephalogram decreased. In the preterminal and terminal phases from 40000 R and up, reflex activities became paroxysmal, and nervous reactivity increased markedly. The electroencephalographic pattern disappeared, and respiration became increasingly irregular and spasmodic until the animals died. (BBB)

**31819** RADIATION-INDUCED EOSINOPHIL MIGRATION ON SUBLETHAL TO SUPRALETHAL WHOLE-BODY IRRADIATION OF RATS, IN A SINGLE DOSE. QUANTITATIVE STUDIES ON EOSINOPHIL DISTRIBUTION IN THE BONE MARROW, LUNGS, DUODENUM, SPLEEN AND PERIPHERAL BLOOD. Chone, B.; Hainig, H. (Universitat, Heidelberg). Blut, 10: 173-85(1964).

Whole-body irradiation (100 to 1000 R $^{60}$Co) causes morphological changes in cells and alterations in the eosinophil distribution that appear to lie in inverse relationship to the dose of radiation. The main reactive organs seem to be the bone marrow and the duodenum, which contain the highest percentage of eosinophils. Changes followed for 21 days after irradiation did not show a wavelike change in the eosinophils distribution. With small doses (up to 500 R) the changes are mainly regulative, but with doses near the lethal level, reactive cellular changes occur. In recoverable cases, there is an excess of eosinophils from the fourth week onwards, many times higher than the initial values. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31820** HEMATOLOGICAL STUDIES ON THE SPLEEN OF RATS AFTER X-RAY IRRADIATION. Diethelm, L.; Lorenz, W. (Johannes-Gutenberg-Universitat, Mainz). Blut, 10: 253-75(1964).

Male rats weighing 130 to 180 gm were given whole-body irradiation doses of 600 to 630 R. The life expectancy was the same in both groups; neither radiosensitivity nor speed of recovery was affected by preliminary radiation with 630 R. Eight days after whole-body irradiation with 600 R, there were histological and cytological signs of active and varied hematopoiesis in the spleen of about 75% of the animals. Lymphopoiesis originating from the large lymphatic reticulum cells was often exceeded by haematopoietic activity in the red pulp where there was active erythropoiesis and megakaryopoiesis together with formation of plasmoblasts, lymphoid plasma cells, and new formation of granulocytes. The capacity for regeneration and the pluripotency of young reticulum cells was specially striking. (Excerpta Med., Sec. XXIII, 2: No. 4, (Apr. 1965))

**31821** THE EFFECTS OF RADIATION ON THE HARD TISSUES: THE EFFECT OF RADIATION ON THE LENS. Adachi, Tadashi; Horiughi, Jun'ichi (Tokyo Medical and Dental Univ.). Bull. Tokyo Med. Dental Univ., 8: 135-45(1961).

The following aspects of radiocataractogenesis was studied in rabbits: (1) radiation dose and cataract formation, (2) effect of age of animals, (3) effect of fractionated irradiation, (4) cataractogenic dose and epilation dose. Doses of 200-kv x rays were from 500 to 2000 R in single irradiations, and in the age study 2000 R was delivered. In the study of fractionated irradiation, the following doses and treatment times were adopted: 2000 R in 2, 4, and 10 days, 1500 R in 3 days, 3000 R in 10 days, and 3500 R in 28 days. A new photographic method was used to register the lens opacities. The latent period for onset of the lens opacities was greatly affected by dose of radiation. In single dose of 500 R, only one of four rabbits showed minute vacuoles 9 weeks after irradiation. In all animals irradiated with 1000 R and more, early changes of the lens were observed ophthalmoscopically, within five weeks after irradiation. At first, fine granular opacities were seen at either end of posterior suture line or equatorial region of the lens. In all rabbits, irradiated with single doses of 1500 and 2000 R, the early lens opacities changed into mature cataract. In the 1500-R group, five rabbits survived more than 12 weeks after irradiation and mature cataract occurred 9 to 12 weeks after irradiation. All three rabbits irradiated with a single dose of 2000 R showed mature cataract 8 to 10 weeks after irradiation. In some cases, severe ulceration of the cornea was observed before opacities of the lens became marked. The progression of radiation cataract was greatly affected by age. Onset of early lens opacities was seen 4½ to 5 weeks after irradiation in young animals (10-week-old) and 9 to 11 weeks in the adult, while in the younger group (4 to 6 week old), early lens changes appeared 2½ to 3½ weeks after irradiation. Mature cataract developed 12 to 14 weeks after irradiation in 10-week-old rabbits and at 20 to 25 weeks in the adult group. Thus, the younger the age, the earlier the onset and more rapid the progress of the cataractous changes. After 2000 R in 4 days, lens opacities occurred 2 to 3 weeks after irradiation, and gradually increased in density in same manner as observed in single irradiation of 2000 R. After 2000 R in 10 days, there was no evidence of lens opacities in all four animals observed more than 12 weeks after the completion of irradiation. After 1500 R in 3 days no progressive lens changes were observed. After 3000 R in 10 days, early lens opacities, noted in all animals, increased and 12 weeks after irradiation became ring-shaped at the subcapsular and equatorial region. After 3500 R in 28 days, early lens changes were already noticed at the time of completion of irradiation, and mature cataract was seen within 12 weeks. After single doses of 500 R, no eyelid epilation occurred. When complete epilation around the eyelid was observed as seen after single doses of 1500 R or more, the lens changes inevitably progressed to mature cataract. The threshold dose level of radiation cataract for young rabbits was about 1500 R of single irradiation (200-kvp x rays). The latent period for the mature cataract was greatly affected by age of animals. (BBB)

**31822** ADDITIVE CYTOTOXICITY OF 5-FLUOROURACIL AND GAMMA-RADIATION ON DIPLOID CELL STRAINS. Lowry, G. M. (Pasadena Foundation for Medical Research, Calif.). Cancer Res., 25: 760-3 (June 1965).

An attempt was made to quantitate the effects of γ-radiation, 5-fluorouracil (5-FU), and the combination of the two on established mammalian cell lines and euploid cell strains maintained in tissue culture. Preliminary experiments suggested that treatment of cell lines with 100 μg/ml 5-FU for a 2-hr period produced a cytotoxic effect on the total populations, which masked the effect of combined therapy. Treatment of diploid cell strains of rabbit endothelium with 5–25 μg/ml 5-FU for 12 hr, followed by exposure of the cells to 400 R γ-radiation from a $^{60}$Co source resulted in a population depletion equivalent to the calculated summation of each treatment alone. Therefore, it was concluded that 5-FU and γ-radiation, in combination,

acted additively rather than synergistically. Although a heteroploid cell line showed a response analogous to the diploid cell strains, the importance of the latter as a test object is discussed. (auth)

**31823** AN ISLAND OF 1,000 INHABITANTS SUITABLE FOR COMPARATIVE STUDIES ON HIGH BACKGROUND RADIATION. Weir, R. N. (Queen Elizabeth Hospital, Blantyre, Nyasaland, S. Africa). Central African J. Med., 10: 169-73(1964).

A geological survey of Chilwa Island in 1952 revealed marked radioactive changes at three localities. These were: the floor of the Chirima arena in the area of Chirima village; the summit plateau; and dyke-like carbonatitic bodies on slopes above the Chirima arena. The arena is an area of approximately 120 acres. Gamma-ray intensity was highest in an elongated zone roughly parallel to the northern and southern margin of the area. Channel samples collected from this area in 1954 indicated an equivalent uranium content of between 0.020 and 0.031%, confirming the isorad map produced during the 1952 investigation. It is clear that the radioactive anomaly in the arena is due to accumulation of radioactive debris derived from the radioactive dykes on the carbonatite slopes. These dykes contain up to 2.14% thoria. It was decided to investigate the effects of this high background radiation upon the health of the population. The background radiation was estimated to be approximately 30 times normal. There were approximately 1000 inhabitants. Two villages were located within the area of interest. One was nearest the center of the arena and was chosen as the test village. Another village lying outside the area of radioactivity was chosen as a control village. The total white cell counts and hemoglobin estimations were used as indicators. Capillary blood from the finger was used. Most of the persons had lived in the test village since birth. An unusual type of skin lesion was found. The skin lesion resembled very closely the skin reactions following intensive deep x-ray therapy. No cases of this condition occurred in villagers living outside the arena. The blood pictures of three young men were also of interest. All three had leucocyte counts between 2,000 and 3,000 per c.m.m. The polymorph count in each case was markedly decreased, whereas the lymphocyte count was increased. The hemoglobin estimations averaged 80%. The skin lesions could be differentiated from tropical ulcers, inasmuch as the area had not seen tropical ulcers in the last 15 years. The study concluded that the low white cell count in the test village was due to exposure to radiation. Recommendations are made that future studies involve photographic film badges and also studies of the bones from human bodies in the graves would add information. Also investigation involving the fish in the lake, as well as vegetation and wildlife, would be of interest. (TCO)

**31824** THE DYNAMICS OF CELLULAR CHANGES, DEMYELINATION AND GLIAL PROLIFERATION CAUSED BY IRRADIATION OF THE CNS WITH SMALL DOSES. A SYNTHESIS OF STUDIES FROM 1961-1963. Vasculescu, T.; D'Andre, H.; Ratiu, H.; Andronescu, N.; Valeanu, A.; Kovacs, M.; Nicoara, Z.; Rosemberg. A.; Diacu, L. Clujul Med., 36: 70-90(1964).

Studies from 1961-1963 on the role of technical factors in irradiation and their relationship to phylogenetic development are reviewed. Human application of the conclusions for perfection of methods and techniques individually adapted to the syndromes and patients are considered. Studies on guinea pigs, dogs, and chickens showed the same types of alterations, differences in radiosensitivity, differences in adaptation, predominance of prompt reversibility of the changes in the central nervous tissue of guinea pigs, predominance of functional re-structuration in the CNS of dogs, and an intermediate situation in chickens. (TCO)

**31825** THE MECHANISM OF RADIORESISTANCE OF NUCLEOTIDES IN THE SOLID PHASE. Marcel, M.; Van De Vorst, A. (Universite, Liege). Compt. Rend., 259: 2027-9(1964).

A study was made, by means of electron spin resonance, on certain components of RNA, with reference to their resistance against ionizing radiation. The increase in radiosensitivity observed from nucleosides to nucleotides is largely due to the fact that in the latter the base no longer acts as a protective element, in contrast to the nucleosides. The accumulation of phosphate groups does not modify the effect produced by one such group. (Excerpta, Med., Sect. XXIII, 2: No. 4(Apr. 1965))

**31826** EFFECTS OF IRRADIATIONS WITH X RAYS ON THE EMBRYONIC DEVELOPMENT AND THE REGENERATION CAPACITY FOR HATCHING OF POLYCELIS NIGRA (TURBELLARIE, TRICLADE). Le Moigne, Albert (Universite de Paris, Orsay, France). Compt. Rend., 260: 4627-9(Apr. 26, 1965). (In French)

Irradiations with x rays can destroy the neoblasts during the embryonic development of the planarian and can suppress the regeneration capacity without inhibiting the differentiation of the rudiments already determined at the time of irradiation. (tr-auth)

**31827** THE CLINICAL STORY OF RADIATION DAMAGE. Brucer, Marshall. Conn. Med., 28: 167-70(Mar. 1964).

Radiation injury in man is reviewed in terms of intentional (therapeutic) and nonintentional (accidental) situations; from the point of view of contaminating and noncontaminating radiation; influence on various body parts; acute and chronic types of injury; diagnosis and treatment of radioinjury. The distinction is made between somatic damage, which is the kind that affects the body cells or material within the lifetime of the particular thing being irradiated, and genetic damage, which produces an effect in the reproductive mechanism, not necessarily in the original nongenetic part. It is then transferred to the next generation. Usually, the differentiation between somatic and genetic radiation is confined to living organisms that have a genetic type of reproduction. Another distinction that has been made has been to distinguish immediate from delayed effects. A distinction between various kinds of radiation can be made purely on the basis of the effect, or distinctions may be based upon purely chemical effects. Distinctions are also made on clinical grounds. It is suggested that all these distinctions are necessary in considering radiation damage; none is adequate in itself. (TCO)

**31828** DERMATOLOGICAL ASPECTS OF THE ACUTE RADIATION SYNDROME. Morczek, A. (Medical Academy, Magdeburg, Ger.). Deut. Gesundheitsw., 19: 1772-6(1964).

A survey of the clinical phenomena of the radiation syndrome and the possibilities of its treatment are presented. The reactions of the skin are discussed. (TCO)

**31829** THE EFFECT OF MULTIPLE X IRRADIATIONS ON THE CONTENT OF CATECHOLAMINE IN VARIOUS PARTS OF THE NERVOUS SYSTEM. Khripchenko, I. P. Dokl. Akad. Nauk Belorussk. SSR, 8: 818-20(Dec. 1964). (In Russian)

Male white rats were given a daily x-ray dose of 40 R, until they had received an overall dose of 760 R. The variation in adrenalin (AD) and noradrenalin (NAD) contents was determined fluorometrically in the cerebrum, the cerebellum, and spinal cord on the 15, 30, 60, 90, and 120th day after irradiation. The content of AD and NAD remains high in the cerebrum even 4 months after the irradiation (103% greater than in the controls). The NAD content remains high, but the content of AD in the cerebrum varies in a cyclic fashion. The content of AD and NAD in the cerebellum is low by 35% on the 30th day after irradiation, and has almost returned to normal on the 120th day after irradiation. This decrease is principally due to the decrease in AD content during this period, which is 46% lower than the control 120 days after the

irradiation. The decrease in content of AD and NAD in the spinal cord is principally due to the sharp decrease of adrenaline in the spinal cord. In spite of the absence of clinical symptoms of sickness, serious disturbances in the content of adrenaline and noradrenaline still exist in the cerebrum and in the spinal cord. (TTT)

**31830** THE TREATMENT OF OSTEORADIONECROSIS OF THE FACIAL BONES. Rehrmann, Alfred (Klinik fur Kiefer und Gesichtschirurgie, Duesseldorf, Ger.). Fortschr. Kiefer-Gesichtschir., 8: 154-9(1962). (In German)

Three cases of patients who developed osteoradionecrosis after radiotherapy of cancers of the head region are reported and illustrations of the lesions shown, before and after surgical treatment. The clinical features of radiation necrosis in the upper and lower jaw and in the frontal bone are described and the problem of timing and methods of surgical treatment are discussed. Difficulties may arise from the fact that the extent of bone damage may be impossible to determine. In the lower jaw this can be dealt with by extensive resection but in the other bones a more conservative method is advised. The danger of causing further damage by radical operations in the upper jaw is emphasized. Further difficulties arise if the neighboring soft tissues themselves have suffered severe radiation damage. In such cases simultaneous plastic treatment is necessary. In planning treatment the possibility of plastic surgery should be considered from the beginning. In many cases it may then be easier to decide at the beginning of treatment on radical removal with immediate or subsequent tissue replacement instead of radiation therapy. In general, osteoradionecrosis is more frequent in the lower than upper jaw, presumably because sequestration of necrotic bone occurs more readily in the mandible. Prophylaxis of osteoradionecrosis is considered, an important aspect being the avoidance of radiotherapy for benign tumors of the facial region and the surgical removal of these and premalignant lesions rather than resorting to irradiation. (BBB)

**31831** TREATMENT OF MASS CASUALTY BURNS. Pessereau; Montell; Morvan. Gaz. Med. France, 71: 2237-50(June 10, 1964). (In French)

The nature of burns and other injuries resulting from a thermonuclear explosion is described and the treatment of large numbers of casualties for burns is outlined. (BBB)

**31832** PHARMACOLOGICAL STUDIES ON RABBITS IRRADIATED WITH NEUTRONS. Nakatsuka, Masayuki; Aratani, Harue; Higaki, Yuzaburo; Hashimoto, Takao; Hirozane, Toshio (Hiroshima Univ.). Gencho Hiroshima Igaku, 12: 513-24(Nov.-Dec. 1964). (In Japanese)

Rabbits each weighing about 2.5 kilograms were irradiated with fast neutrons from a 150 KV Toshiba T (d,n) neutron generator with doses of 0.6 to 5.0 rad. Doses were repeated at four or two week intervals, and some lots received as much as six exposures. Body weights of the animals tended to decrease in the period immediately after irradiation, then tended to increase. The weights were generally considerably below those of the controls, however, rabbits which had undergone six exposures had nearly the same weight increases as those of controls. About a fourth of the animals developed diarrhea within four weeks after initial exposure and died while the survivors showed remarkable resistance to radiation. Total urine output was recovered and analyzed for total 17-ketosteroid, sodium, and potassium, and the variations of these components with dose are shown. The irradiated animals showed distress symptoms which were most readily discerned in the eyes. Ophthalmic observations and measurements are described. The results obtained in this study are compared with results reported by other workers along similar lines. No definite conclusions are drawn to explain the various trends observed in this study. (TTT)

**31833** THE EFFECTS OF RADIATION ON GROWTH PATTERN OF MICE. Carmon, J. L. (Univ. of Georgia, Athens). Growth, 29: 85-96(Mar. 1965).

An inbred colony (expanded by brother-sister matings) of BALB/C mice was used to investigate the effects of $\gamma$ and neutron irradiation on growth. Male mice 70 days old were exposed to $^{60}$Co $\gamma$ radiation and/or 14.7-Mev neutrons according to the following dose schedules: unexposed controls, 100 R $\gamma$, 200 R $\gamma$, 10 Rad neutron, 20 Rad neutron, 50 R $\gamma$ + 5 Rad neutron, and 100 R $\gamma$ + 10 Rad neutron. The irradiated mice were then bred with unirradiated females, and male progeny were irradiated at 70 days of age as before. Selection for the next generation was within group and the males received the same radiation dose as their parent. Data were collected on 8000 individuals over four generations. A three-parameter logistic model was used to approximate growth. The three parameters of the model were $\beta$ (final size), $\alpha$ (multiplier of initial size to give growth) and $\rho$ (the growth factor). The same mature weights were reached in all treatment groups. Generation and sire effects were of minor importance for all three parameters. Random error accounted for a majority of the variance, 74.6, 66.5, and 54.9% of the parameters $\beta$, $\alpha$, and $\rho$. The dam component was the second in importance accounting for 14.0 and 26.0% of the total variance for the parameters $\beta$ and $\alpha$. For parameter $\rho$, the dam component accounted for 5.6% of the variance in the control group but increased to 33.6% in the treated groups. These data indicate considerable nonadditive genetic and/or maternal effects operating for these parameters. Thus radioinduced genetic damage was found to accumulate in irradiated lines of mice where only the males were treated, and much of the genetic decrement was recessive. It has been suggested that milk produced in the mouse, as measured by growth, is very sensitive to acute radiation. Pronounced retardation of growth where exposure of the mother was 200 R or more was noted previously, and the reduced growth was due to starvation rather than toxic substance in the milk. (BBB)

**31834** THE EFFECT OF RADIOACTIVE GOLD ON SOME IMMUNOLOGICAL PROCESSES. De Gregorio, P. Hospital (Rio de Janeiro), 66: 47-57(1964).

Radioactive gold in high doses retards or prevents the formation of antibodies (agglutinins) and separates the retarded hypersensitivity from the immediate hypersensitivity. Isotope doses which cause the disappearance of hypersensitivity of the retarded type, also inhibit the appearance of immunity of the graft and the intradermal reaction to skin extracts. This suggests that the immunity of the graft should be regarded as a form of retarded hypersensitivity (tuberculin type) and not as a form of immediate immunity (Arthus' type). This is also confirmed by the fact that the lymphoid cells obtained from animals treated with small isotope doses are capable of transferring the immunity of the graft and the hypersensitivity of the retarded type to the skin extract, whereas those obtained from animals treated with large doses transfer neither the immunity of the graft nor the retarded hypersensitivity. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31835** EXPERIMENTAL ANIMAL STUDIES OF ENTERIC LEAD EXCRETION. Witschi, H. P. (Universitat, Bern). Intern. Arch. Gewerbepathol. Gewerbehyg., 20: 449-60(May 12, 1964). (In German)

In rats acutely poisoned with Pb the movement of this metal from the blood stream into the intestinal lumen was quantitatively evaluated following whole-body irradiation. The irradiation dose was 800 R, administered at a rate of 38 R/min. This was administered three days before the Pb was given to the animals. Typical radiation injuries, such as hyperemia of the intestinal wall and liquifaction of the intestinal contents were observed, but there were no hemorrhages. The gastrointestinal excretion of Pb was measured in various segments of the wall. These included stomach, duodenum, jejunum, ileum, cecum, and colon. Excretion of Pb in the duodenal region was mark-

edly increased in the irradiated animals as compared to control animals. After instillation of proteinase inhibitor into the lumen of the duodenum, the duodenal Pb concentration was significantly increased. This was not affected by stoppage of bile flow into the duodenum. Production of an increased intestinal protein elimination by radioinduced exudative enteropathy or by prevention of intraintestinal protein degradation thus gives rise to increased Pb excretion into the duodenum. It is possible that in blood Pb may be transported by a protein and enter into the enteric circulation of serum proteins. (BBB)

**31836** EFFECTS OF GAMMA RAYS, FAST NEUTRONS AND ETHYLENIMINE ON THE FREQUENCY OF CHROMOSOME ABERRATIONS IN WINTER WHEAT. Gorin, V. E. Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 12, Ser. Biol.-Med. Nauk, No. 3, 117-21(1964). (In Russian)

The mutagenic factors, studied in the present investigation (gamma rays, fast neutrons, and ethyleneimine), had different effectivities in the induction of chromosome aberrations in winter wheat after exposure of air-dried seeds. Fast neutrons showed approximately 15 times more effectiveness than gamma rays. Ethyleneimine (at concentrations of 0.025 and 0.05%) produced fewer chromosome aberrations than ionizing radiations at all irradiation doses studied. The effect of 0.1% solutions of ethyleneimine gave high numbers of chromosome aberrations (44.4%). Secondary characteristics of the effects of ethyleneimine were that it produced comparatively greater chromosome fragments and fewer bridges in comparison with ionizing radiations. Fast neutrons and gamma rays, with equal reduction of the longevity of plants of the first generation, produced approximately equal numbers of chromosome aberrations which made it possible to indicate the absence of important differences in the character of the biological effects of these two radiations. (tr-auth)

**31837** ACUTE MYELOMONOCYTIC LEUKEMIA AFTER RADIOIODINE THERAPY OF HYPERTHYROIDISM. Johnson, John E. Jr. (Univ. of Texas, Galveston). J. Am. Med. Assoc., 179: 572-3(Feb. 17, 1962).

Development of acute myelomonocytic leukemia after radioiodine therapy of hyperthyroidism 2 yr after treatment of a 55-yr-old man with a total of 17.2 mC of $^{131}I$ for diffuse toxic goiter is described. He was initially given 12 mC of $^{131}I$ orally, and during the next 4 months he showed considerable improvement. However, he was considered to be objectively still thyrotoxic, and because of previous congestive heart failure, it was thought desirable to complete his therapy with an additional dose of 7.2 mC of $^{131}I$. He continued to improve, his goiter completely disappeared, and he felt well and was considered to be euthyroid. One year later he was admitted to the hospital because of profound weakness. The total white blood cell count was 3800; blast forms and many promyelocytes were seen on the peripheral blood count. A marrow specimen was very hypocellular but showed the features of acute myelomonocytic leukemia. The radiation dosage delivered to the patient as a result of his radioiodine therapy was estimated as 9000 Rad to the thyroid, 32 to the blood, 26 to bone marrow, and 3 over the entire body. This patient is the 19th instance of leukemia occurring after radioiodine therapy of hyperthyroidism to be reported. Symptoms attributable to leukemia first developed 22 months after his first dose of $^{131}I$; diagnosis was made at 26 months; and death occurred at 29 months. It is suggested, however that in the dose range that is effective in hyperthyroidism, the absolute increase in risk will prove to be very small. (TCO)

**31838** ACCIDENTAL ACUTE WHOLE-BODY GAMMA IRRADIATION OF SEVEN CLINICALLY WELL PERSONS. McCandless, James B. (Puerto Rico Nuclear Center, Mayaguez). J. Am. Med. Assoc., 192: 185-8(Apr. 19, 1965).

Clinical data are provided for six Puerto Ricans, including two women, and a Chinese-American man who were accidentally exposed to acute whole-body $\gamma$ radiation at doses of 4 to 100 R. On July 24, 1962 these seven persons were accidentally exposed at the Puerto Rico Nuclear Center, Mayaguez, by being present in or very close to the gamma room when fuel elements from the swimming-pool type reactor were accidentally placed close to the plate of the gamma room. Blood was taken for complete hematologic examination, clotting studies, blood electrolytes, serum electrophoresis, blood urea nitrogen, and transaminase determinations. Bone marrow studies were done, and a stool study, urinalysis, electrocardiograms, sperm counts, and daily complete blood counts were carried out. Special attention was paid to examination of the skin, eyes, gastrointestinal system, water intake and output, and reproductive system. The highest dose (100-R) was received by a 39-year-old Puerto Rican who was frightened and complained of abdominal cramps and headache. A slight increase in thirst was noted. He was hospitalized five days. Lab studies showed normal results except for some toxic-type granulation of leukocytes. White blood cell count (WBC) fell to a low of 3400 on the tenth day. The patient had a slight monocytosis, and vacuolization of the cytoplasm and granulation of monocytes and lymphocytes from toxic reaction. The patient noted slight loss of hair on the seventh to 14th days but physical examination on the 18th day revealed no changes. Abdominal complaints disappeared and he returned to work one month after the incident. The other subjects, who were estimated to have received 55, 24, 18, 18, 8, and 4 R, showed only minor changes in WBC counts. Since six individuals were wearing film badges, exposure could be determined fairly accurately. Only $\gamma$ radiation (average energy 2+ Mev) was involved, with no neutron component. Although the early hematologic changes and subjective symptomatology are mild when the dose is less than 100 R and no specific therapy is indicated, in the present incident there were some hematologic findings attributable to irradiation. Because this incident involved pure $\gamma$ radiation, comparison of the results of the hematologic examination in this incident with others which involved neutrons in the same dose range has special importance in estimating the relative biological effectiveness of fission neutrons on human leukocytes. With mixed radiation exposure and evident burns, trauma, or infection, the early WBC counts logically, have previously been considered of little diagnostic value. In the cases reported here involving only pure whole-body $\gamma$ radiation, the complications of burns, trauma, and infections were excluded. Atypical lymphocytes were very common the first few days except in the patient who was exposed to only 4 R. The lymphocyte counts showed instability in the patients (the four cases) who received the highest doses, and lymphopenia developed on the fourth to fifth days. In the established absence of infection, toxicity, or trauma, it is probable that radiation did cause hematologic abnormalities. Normal lymphocyte count and the absence of atypical lymphocytes can be taken as presumptive evidence of very low levels of acute exposure (less than 8 R here). Three of the four most heavily exposed patients showed a neutrophilia and lymphopenia on the fourth or fifth day. It is important that neutrophils and lymphocytes be counted daily in patients known or suspected of being exposed to an acute radiation dose greater than 20 R to confirm the diagnostic value of this fourth-to-fifth day neutrophilia with leukopenia. (BBB)

**31839** CENTRAL-NERVOUS-SYSTEM REACTIONS TO IONIZING RADIATION. Feder, Bernard H. (Univ. of California, Los Angeles). J. Am. Med. Assoc., 192: 297-8(Apr. 26, 1965).

Experiments are described which demonstrate that the central nervous system of animals is stimulated to respond to low doses of ionizing radiation. The functional responses of rats to low doses of ionizing radiation are seen in the forms of several reactions. The types of central nervous system effects include the following: arousal of the animal by irradiation, with demonstration of associated electrical changes in the brain by electroencephalography, detection of minute doses of radiation, as shown by predictable responses of conditioned animals

to radiation exposure, and avoidance of radiation exposure, and of situations previously associated with it, as shown by the animal's acquired reluctance to repeat the previous experience. Another functional effect of ionizing radiation is distinguished as the phosphene effect, an excitation of the retina which gives a luminous sensation. The doses of x radiation necessary to produce this effect are considerably higher than those which produce the above phenomena. Furthermore, the arousal, detection, and avoidance responses occur as readily in animals with the eyeballs removed. Thus the phosphene effect apparently plays no role in these phenomena. Rats could be aroused from sleep by exposure to about 20 mR of x radiation in air. Avoidance of conditions associated with prior exposure to ionizing radiation is dose dependent. A one minute exposure of 10 R in air was necessary to elicit consistent responses in the rat. A period of several hours must elapse after the exposure before such avoidance behavior is seen. After exposure to x radiation, the rat subsequently tended to avoid the compartment in which the exposure occurred. Also, the preference for saccharin flavored water was modified by irradiation. The abdomen seemed to be the anatomic part related to such avoidance behavior, inasmuch as the aversion reactions were more regularly produced by radiation exposure of the abdomen than of the head. Disturbances of the gastrointestinal tract may be involved in producing these effects. (TCO)

**31840** IRRADIATION IN UTERO. J. Am. Med. Assoc., 192: 410(May 3, 1965).

Some early and recent evidence relating to the hazards of prenatal radiation exposure are reviewed briefly. Harmful effects of ionizing radiation on the developing fetus were first noted during the early days of radiation therapy. Thus in 1929 it was reported that large doses of radiation to the pelvic region of pregnant women sometimes resulted in microcephaly in the offspring. More recently, it has been suggested that diagnostic irradiation during the prenatal period may result in an increased incidence of leukemia in the exposed children. In children who were exposed in utero to ionizing radiation from the atomic bomb in Hiroshima and Nagasaki an increased incidence of microcephaly and mental retardation was noted. Later data show that these children exposed in utero lagged behind nonexposed controls during adolescence in several aspects of growth and development. With few exceptions the exposed children could be considered individually within normal limits in terms of growth and development, and the differences became apparent only when a suitable control group was used for comparison. Thus, in addition to easily recognized abnormalities, irradiation in utero may result in more subtle defects. The lag in growth and development was most pronounced in children whose mothers had received a radiation dose of 50 rad or more. However, there is no convincing evidence that a threshold exists for radiation effects, and it is likely that smaller amounts of radiation might cause even more subtle changes. The thalidomide tragedy has focused attention on a variety of agents which are tolerated by the mother but harmful to the fetus and, it is suggested, prenatal irradiation may be such an agent. Since radiation effects may occur which are detrimental to the fetus but are not readily apparent, unnecessary irradiation of the fetus during pregnancy should be avoided. (BBB)

**31841** BEHAVIORAL AND NEUROPATHOLOGICAL CHANGES IN THE RAT FOLLOWING X-IRRADIATION OF THE FRONTAL BRAIN. Burt, Dorothy H.; Ingersoll, E. H. (Medical Coll. of Virginia, Richmond). J. Comp. Physiol. Psychol., 59: 90-3(Feb. 1965).

A recent review concluded that several thousand-roentgen doses of ionizing radiations do not interfere with the learning of relatively difficult problems in the adult animal. This conclusion is based on studies in which radiation malaise or motivational changes were shown not to inhibit performance. The major evidence points to a facilitating effect, with irradiated rats being less distractible, or having a narrower range of attention and, therefore, frequently superior to control animals in the learning of many tasks. In view of the neuropathological changes found in the brain following irradiation, objections are raised to acceptance of the idea that ionizing radiations enhance or facilitate learning. Therefore, attempts were made to reexamine behavioral changes associated with x irradiation to a restricted area of the brain. This study was designed to determine the effect of 5000 R of x irradiation to the frontal area of the cerebrum in 65-day-old rats on an alternating pattern of partial delay of reward, and to examine the neuropathological changes in the irradiated frontal areas. A learning deficit was demonstrated in these rats subjected to irradiation of the frontal area of the cerebrum. The irradiated rats were retarded in the acquisition of an alternating pattern of immediate and delayed reward. The retardation was clearly a learning deficit and not attributable to nonassociative factors. It is suggested that earlier studies in which irradiated rats demonstrated superior performance may have involved learning tasks which were not sensitive enough to detect learning deficits in adult irradiated rats. Neuropathological examination of the irradiated brains revealed extensive damage to both neuronal and glial elements. The irradiated nervous tissue exhibited enlarged oligodendrocytes and astrocytes with swollen processes. The neuron cell bodies were edematous and their processes greatly distended with enlarged clumps of formazan granules. Areas of necrosis were observed which had little resemblance to normal cell structure. Blood vessels in the area of necrosis showed marked changes in structure and many appeared to be occluded by debris. In many such vessels there were accumulations of large globules of PAS-positive material in the vessel walls. The localization of the lesions in the frontal portion of the cerebrum associates this cortical area with the behavioral deficit observed. As both neuronal and glial elements were affected, the association of the observed behavioral patterns with a particular cell type could not be made. (BBB)

**31842** LEUKOCYTE KINETICS IN THE DOG STUDIED BY CROSS CIRCULATION. Thomas, E. Donnall; Plain, George L.; Thomas, Dorothy (Univ. of Washington, Seattle and Mary Imogene Bassett Hospital, Cooperstown, N. Y.). J. Lab. Clin. Med., 66: 64-74(July 1965).

Leukapheresis was accomplished by cross circulating a donor dog with a series of recipients made leukopenic by irradiation. The number of leukocytes moving from donor to recipient was calculated from the volume of blood exchanged and the mean difference in white blood cell count for each leukocyte type. The circulating leukocytes of the donor were almost completely removed during the first 10 to 15 minutes. Mobilization of leukocyte reserves began after about 15 minutes. In the first hour, large numbers of polymorphonuclear leukocytes were mobilized. In the subsequent hours, the myeloid cells mobilized were principally band forms. After 5 to 6 hours, nearly complete removal of leukocyte reserves was accomplished. Over a period of 7.5 hours, the first donor dog gave up $8.23 \times 10^9$ leukocytes per kilogram, of which $1.81 \times 10^9$ were polymorphonuclear leukocytes, $4.96 \times 10^9$ were band forms, and $0.90 \times 10^9$ were lymphocytes. Over a period of 6.3 hours, the second donor dog gave up $10.12 \times 10^9$ leukocytes per kilogram, of which $3.13 \times 10^9$ were polymorphonuclear leukocytes, $5.42 \times 10^9$ were band forms, and $1.42 \times 10^9$ were lymphocytes. These studies document a large extravascular store of granulocytes and lymphocytes available for immediate mobilization. Immature leukocytes were not released from the marrow even when the peripheral blood leukocytes were reduced to very low levels. The number of lymphocytes removed was approximately 6 times the number originally present in the circulating blood. (auth)

**31843** COMPARISON OF THE CARCINOGENIC AND COCARCINOGENIC EFFECTS OF ULTRAVIOLET LIGHT ON HAIRLESS MICE. Epstein, John H. (Univ. of California, San Francisco). J. Natl. Cancer Inst., 34: 741-5(June 1965).

The effects of the chemical carcinogen 7,12-dimethylbenz[a]anthracene (DMBA) on ultraviolet light (UVL) carcinogenesis were investigated. In the study, $15.34 \times 10^7$ ergs per $cm^2$ of mid-UVL energy (2800–3200 A) applied over a 29-week period proved carcinogenic. A single application of DMBA 6 weeks before the initiation of the UVL exposures resulted in a significant acceleration of tumor appearance and growth. The findings simulate those described for carcinogenic summation rather than tumor promotion. However, an equation between the mechanisms of UVL and chemical carcinogenesis must be considered cautiously. (auth)

**31844** TRISOMY 17-18. AN EVALUATION OF PRECONCEPTIONAL PARENTAL IRRADIATION AS A POSSIBLE ETIOLOGIC FACTOR. Townes, P. L.; Dehart, G. K. Jr.; Ziegler, N. A. (Univ. of Rochester, N. Y.). J. Pediat., 65: 870-9(1964).

Three new cases of trisomy 17-18 are presented. Of particular interest is the occurrence of cleft palate and lip, third degree hypospadias, rectourethral fistula, split scrotum, and imperforate anus in this syndrome. An attempt is made to evaluate preconceptional parental irradiation as an etiologic factor in this syndrome. Although the data are presently inadequate, further consideration is clearly indicated. The paradoxical association of prolonged gestation and reduced birth weight is confirmed. Examination of the larger number of cases now available suggests that advanced maternal age is probably of lesser significance in this syndrome than in mongolism. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31845** β-GLUCURONIDASE AND ESTERASE ACTIVITIES OF RAT TESTIS AFTER X-RAY TREATMENT. Pecora, Paolo; Arata, Luciano (Universita, Rome). J. Reprod. Fertility, 8: 281-5(Dec. 1964).

To elucidate the relation between β-glucuronidase, esterase, tubular epithelium damage, and state of the interstitial cells, the effects of x-ray treatment of the scrotal area of rats on the β-glucuronidase and esterase activities of the testes were examined. The cells of the seminal line disappeared while the interstitial tissue was well preserved. Ten days after 600-R local irradiation of the testes the number of spermatogonia was greatly reduced, especially in the tubules close to the testicular surface. The other cells of the seminal line appeared to be normal. The lumen of some tubules was filled with desquamated cells and with an amorphous eosinophilic substance. Thirty days after irradiation, a decrease in the diameter of the tubules was evident and a few spermatozoa and Sertoli cells were recognizable near the basal membrane. Forty days after irradiation, the volume of the testes was greatly reduced and the tubules consisted of a thickened basal membrane with few scattered Sertoli cells and spermatogonia, the latter occasionally in mitosis. After an initial decrease, β-glucuronidase activity tended to increase progressively, reaching double the normal values. Changes in esterase activity were not so clear and significant, but after an initial increase and a subsequent decrease (around the 20th to 30th day after irradiation), a sharp increase of activity occurred. A conspicuous increase of the acetic esterase activity was seen around the 10th and 50th day of experiment, while the valeric esterase activity diminished noticeably around the 30th day and increased above the normal values around the 50th day. The esterase activity observed in the testis of the irradiated rat could be the indirect expression of changes in the Leydig cells during the radiation damage. A similar hypothesis is formulated for the testicular enzymatic activity of the β-glucuronidase type, which seems to be connected with the function of the Leydig cells. (TCO)

**31846** A RARE CASE OF OSTEOGENIC SARCOMA. Leb, Jozsef; Doemoetoer, Laszlo (Fovarosi Istvan Korhaz, Budapest). Magy. Radiol., 17: 13-7(Feb. 1965). (In Hungarian)

A detailed medical history is given of a 35-yr-old woman who entered the hospital complaining of pain in the right leg. It was found that at 11 yr of age she had a dysgerminoma removed from the right ovary. She received an undetermined dose of irradiation on the right pelvic area postoperatively. A hand-sized purple-blue teleangiectasic area developed. X-ray examination disclosed that the right ilium and lateral part of the right sacrum were sclerotic, bone contours were indistinct, and the upper third of the sacroiliac joint could not be distinguished. After a year of intensive treatment she became operable, at which time the sarcoma was partially removed and the patient received 6000-R $^{60}Co$ treatment in four areas and 200 mg Degranol. Her condition improved so that she could walk with a cane. Two months later she returned to the hospital, after which time her condition deteriorated rapidly and despite intensive treatment, she died 9 months after the operation. Subsequent autopsy revealed a head-sized growth of osteoid tissue invading the pelvic area, infiltrating the spine and two-thirds of the upper thigh. The lung also showed several small metastases. It is concluded that this case met all the requirements of radiogenic sarcoma, and, although such tumors are rare, particularly following irradiation of soft-tissue organs rather than the bone itself, in this case the then-growing bone of this 11-yr-old child was stunted as well as being the site of sarcoma development. It is again recommended that benign conditions should only be treated with radiation after all other methods have been exhausted. Utmost care should be taken to protect the patient from x-ray damage, and radiotherapy of children should be undertaken only when absolutely necessary. (BBB)

**31847** THE EFFECT OF THE STORAGE OF METHYLCELLULOSE AND WHOLE-BODY IRRADIATION ON THE SURVIVAL OF MICE. Soevenyi, Ervin; Laszlo, Ferenc; Benkoe, Sandor (Orvostudomanyi Egyetem Rontgenklinikaja, Szeged). Magy. Radiol., 17: 43-7(Feb. 1965). (In Hungarian)

Tests were conducted to see if the storage methylcellulose (MC) in the body affects the survival time of mice after large doses of x irradiation, and whether the x irradiation affects the storage of methylcellulose. In the first series of tests the control mice were injected with 0.5 ml physiologic saline, and three other groups received 0.5 ml of 0.5% MC solution (70% MC of 82,000 mol wt with a degree of polymerization of 450 and 30% carboxymethylcellulose 115,000 mol wt, with a DP of 550), 0.5 ml of 1.5% MC solution, or 0.5 ml of 2.5% MC solution respectively. All groups received 400-R x irradiation 10 to 12 min after the injection. The 30-day mortality rate was 33% in the control group, 75% with 0.5% MC, 60% with 1.5% MC, and 65% with 2.5% MC injections. In the second series of tests the same amounts of MC were injected as in the first series, but the irradiation dose was 500 R; the 30-day mortality figures were 34%, 63%, 55%, 75% for the four groups. In the third series of tests the treatment was repeated, the control group receiving 0.5 ml physiologic saline twice weekly for three weeks and 500-R x irradiation at the end of that period; the second group 0.5% MC twice weekly and 500 R; the third group only 0.5 MC for three weeks; and the fourth group a dose of 600 R initially followed by 0.5 ml 0.5% MC for three weeks. The mortality rates for the four groups were 85%, 90%, 40%, and 95%. It was thus shown that MC administered prior to irradiation does not give radiation protection, also that continued MC treatment either before or after irradiation does not confer radioprotection, but actually increases the mortality rate. Pathologic studies indicated that irradiation did not influence that storage of MC in the reticuloendothelial system as compared to the control animals. These studies indicated that the bone marrow of the treated and untreated animals retained its hematopoietic function, but in the uninjected animals which received only irradiation the regenerative process in marrow started more promptly. (BBB)

**31848** INFLUENCE OF NON-LETHAL DOSES OF RADIATION ON RECOMBINATION IN CHLAMYDO-

MONAS REINHARDI. Lawrence, C. W. (Wantage Radiation Lab., Berks, Eng.). Nature, 206: 789-91(May 22, 1965).

Different samples of zygotes germinating on membrane filters were treated with $^{60}$Co γ irradiation at 30 min intervals from 3 to 7.5 hr after the start of germination. A dose of 1890 Rads at 3780 Rads/min was given, irradiations being carried out in the dark in air at 25°C. The results showed that recombination was influenced by irradiation at only two short stages during germination, and that such changes occurred in the absence of lethality. 5.5 hr after the start of germination recombination was depressed to less than 85% of the control value, a deviation which is significant ($P \approx 0.05$-$0.01$), while at 6.5 hr recombination was increased by nearly 10%. Irradiation with 1890 Rads at other times between 3 and 7.5 hr after the start of germination did not effect recombination. Other results are also discussed. (P.C.H.)

**31849** EFFECT OF VARIOUS AGENTS ON THE DEVELOPMENTAL PHASES OF THE L STRAIN CELLS IN VITRO. Neskovic, B. A. (Laboratory of Experimental Oncology, Belgrade). Nature, 206: 837-8(May 22, 1965).

The effects of gamma irradiation (776 or 1552 Rads) and various chemical agents on developmental phases of the L strain cells were investigated in vitro. It was found that non-irradiated control cells increased during 48 hr by 150%, while the cells irradiated with 776 Rads increased by only 25%, and those treated with 1552 Rads by only 2%. The effects observed when actinomycin or sarcolysine were introduced into the cell cultures were similar to the effects observed with gamma radiation. Thus it seems that the initial effects of these agents are multiple. Conclusions reached from the results are discussed. (P.C.H.)

**31850** CHANGE IN CHROMOSOME NUMBER DURING CONTINUOUS IRRADIATION. Nias, A. H. W.; Ockey, C. H. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature, 206: 840-1(May 22, 1965).

Studies were made on chromosome number in HeLa cells during continuous irradiation (30 Rads/day). After 5 months there was no significant change in chromosome number with the controls, but a downward spread in chromosome number was evident with the continuously irradiated cells. These showed not only the typical chromatid and chromosome damage observed in $X_1$ cells (chromatid and chromosome exchanges, triradicals, duplications, sister-unions, rings, and dicentrics with acentric fragments) but also a smaller frequency of damage surviving from previous divisions now in $X_2 \ldots n$ (dicentrics and rings without acentric fragments, chromosome translocations, and deletions). After continuous irradiation for 12 months at 30 Rads/day there was no significant difference between the growth rates of the irradiated and control populations and chromosome spreads were made directly from the two populations. (P.C.H.)

**31851** RADIATION EFFECT ON INCORPORATION OF TRITIATED VALINE IN CHROMOSOMES OF VICIA FABA. Alvarez, Marvin R. (Brookhaven National Lab., Upton, N. Y.). Nature, 206: 950-1(May 29, 1965). (BNL-8541)

The incorporation of tritiated valine into the structural chromosomal protein of Vicia faba was studied autoradiographically during the post-irradiation period in which chromosomal restitution occurs. An analysis of variance showed that the approximately 2.5 times more labeling observed in the irradiated chromosomes is significant at the 5 percent level. Increased labeling in irradiated chromosomes is explained by an accelerated synthesis of chromosomal protein as a part of the rejoining process. A higher labeling of cytoplasmic protein in irradiated cells suggested the possibility of radioinduced change in the permeability of the cell. (H.G.D.)

**31852** CHARACTER OF PRIMARY AND SECONDARY COLONIES OF HAEMATOPOIESIS IN THE SPLEEN OF IRRADIATED MICE. Juraskova, Vera (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno) and Tkadlecek, L. Nature, 206: 951-2(May 29, 1965).

To investigate the character of the cell composition of secondary colonies growing in the spleens of irradiated mice after the injection of a suspension of cells arising after the injection of bone marrow cells, C57BL mice as hosts were irradiated with 650 R x radiation. Results showed that 1.65 times more colonies of red than of white type developed from the red-type cell suspension, and 2.93 times more red-type than white-type colonies arose from the white-type cell suspension. The character of the secondary colonies was thus not simply dependent on the character of the cells from the primary colony. (H.G.D.)

**31853** DEPHOSPHORYLATION OF POLYNUCLEOTIDES AND SOME OF THEIR COMPONENTS BY ULTRA-VIOLET IRRADIATION. Trapmann, H.; Devani, M. (Universitat, Munich and Akademie des Sanitats- und Gesundheitswesens der Bundeswehr, Munich). Nature, 206: 931(May 29, 1965).

The phosphatatic activity of ultraviolet radiation on polynucleic acids and ribonucleotides is discussed. (H.S.D.)

**31854** EFFECT OF INTERNAL EMITTERS ON LIVER TUMOURS INDUCED BY DIMETHYLAMINOAZOBENZENE. Mahlum, D. Dennis; Palotay, J. L.; Clarke, W. J. (General Electric Co., Richland, Wash.). Nature, 206: 945-6 (May 29, 1965). (HW-SA-3667)

Female rats of the Charles River CD strain were injected intravenously with $^{144}$Ce-$^{144}$Pr or $^{238}$Pu to determine the effect in rats of internally deposited radionuclides on the induction of liver tumors by dimethylaminoazobenzene (DMAB). Rats were fed a diet high in riboflavin and protein to which DMAB was added. Control groups received either no isotope or no DMAB. The effect of radioisotope treatment was to decrease tumor incidence, especially in the group receiving 20μC $^{144}$Ce-$^{144}$Pr. It is suggested that cells in the early stages of carcinogenic development are susceptible to small quantities of radiation and are destroyed before extensive multiplication can occur. (H.G.D.)

**31855** CHANGES OF SPECIFIC CONDUCTIVITY OF BLOOD SERUM IN VIVO AFTER X-IRRADIATION. Hlavaty, V.; Zak, M.; Jirounek, P. (Charles Univ., Prague). Nature, 206: 1057-8(June 5, 1965).

The specific conductivity of rabbit serum was studied after 250, 500, 1000, and 1500 R doses of x radiation. Specific conductivity increased at all doses, but the increase was statistically significant in animals receiving 1500 R. Serum ion concentration immediately following irradiation was considered of great importance. (H.G.D.)

**31856** CYTOPHOTOMETRIC DEOXYRIBONUCLEIC ACID STUDIES ON LIVERS OF XENOGENEIC RADIATION CHIMERAS. Uyeki, E. M.; Buschbom, R. L. (Battelle-Northwest, Richland, Wash.). Nature, 206: 1059-60 (June 5, 1965).

The nuclear DNA content in rat liver parenchymal cells of xenogenic radiation chimeras was observed during the first two weeks after treatment with rat bone marrow or spleen cells to determine whether there was a shift of the parenchymal cell population to one of higher DNA content. Statistical analysis of the results from irradiated mice treated with bone marrow indicated there was not a significant shift of parenchymal cell population to one of higher DNA content at one day post-treatment. However, after the first day there appeared to be a shift to cell populations of lesser DNA content as indicated by the increased proportion of diploids at three, seven, and fourteen days post-treatment. Similar results were obtained in x-irradiated mice given viable spleen cells with two exceptions: fourteen-day values were not significantly different from the control group, whereas the one-day values revealed a shift to a higher DNA class. Mice injected with polyvinylpyrrolidone varied only slightly from the control group in percent distributions. It is concluded that the hepatomegaly observed with the injection of hematopoietic cell and polyvinylpyrrolidone results from an increase in the number of all functional cells rather than from enlargement of individual parenchymal cells. (H.G.D.)

**31857** SPONTANEOUS LYMPHATIC LEUKEMIA IN WISTAR RAT. Svec, F.; Hlavayova, E.; Altaner, C. (Oncological Research Inst., Bratislava). Neoplasma, 12: 15-20(1965).

A study was made to ascertain whether the spontaneous lymphatic leukemia, which occurred in a colony of Wistar rats was transmissible by cell-free filtrates, whether the occurrence of leukemia would be increased in the progeny of animals inoculated and died of this leukemia (vertical transmission), and whether it would be possible to increase the occurrence of leukemia by irradiation. Two 150-R doses were given in attempts to activate the latent virus infection. The lymphatic leukemia was transplantable. In the first passage, following intraperitoneal inoculation of 10-day-old rats, the take was 100% and the average survival was 3 months. In the 3rd passage the period of latency decreased to the half, and from the 7th passage on it was about 3 to 4 weeks only. Among 15 $F_1$ animals leukemia developed in one nonirradiated rat only in advanced age. One tumor (mammary fibroadenoma) was seen in this group. In the $F_2$ generation of 58 nonirradiated animals two became leukemic, the average survival was 2 years. In $F_3$ generation, in one of the 17 irradiated animals fibrosarcoma developed and in another there was mammary fibroadenoma. Of the 95 nonirradiated animals one developed leukemia at the age of about 2 years. In $F_4$, of 8 which were irradiated, none developed leukemia, but mammary fibroadenomas were found in all of them. Of the 49 nonirradiated rats leukemia was found in 2. Studies showed that the spontaneous lymphatic leukemia was not transmitted by an oncogenic virus. From the total of 202 nonirradiated rats leukemia developed in 6, i.e. 3%, which is the same as the occurrence of spontaneous leukemia in this colony of rats. Of the 40 irradiated rats of $F_1$ to $F_4$ generations none developed leukemia. The relatively high incidence of tumors in the irradiated group (30%) can be ascribed to the action of irradiation. (TCO)

**31858** FATAL RADIATION SYNDROME FROM AN ACCIDENTAL NUCLEAR EXCURSION. Karas, Joseph S.; Stanbury, John B. (Rhode Island Hospital, Providence). New Engl. J. Med., 272: 755-61(Apr. 15, 1965).

This account concerns a fatal accident in a $^{235}U$ recovery plant. The patient was cared for in a large general hospital by a staff that had had no previous experience with a similar problem. The patient survived for 48 hr after receiving 10 to 20 times a lethal radiation exposure. He probably received the heaviest radiation dose of any victim of a nuclear accident, and this is considered the first fatality in private industry. On July 24, 1964 this worker was pouring a mixture containing $^{235}U$ from a polyethylene cylinder 12.5 cm in diameter and 120 cm high into a tank 63 cm in diameter containing sodium carbonate. A critical volume was attained by the new geometry near the completion of this operation, and a nuclear excursion occurred. The patient recalled a flash of light and was hurled backward and stunned, but did not lose consciousness. A detailed account is given of the patient's subsequent reactions upon hospitalization, medication received, clinical data, autopsy findings, and steps taken by hospital personnel to minimize radiation hazards to themselves. Shortly after admission to the hospital a survey of the body surface made for $\gamma$ emission showed a reading two ft from the face and upper chest of 40 mR/hr. At the time of death an attendant could have worked within two ft of the patient's head for nine hr to have received the maximum allowable radiation exposure for one week. This estimation does not take account contamination from $\alpha$- and $\beta$-emitting isotopes on the skin and hair or in the excreta, which was the significant hazard. For neutron activation assays, samples of blood, urine, feces, and hair and a gold ring were studied. It was estimated from the $^{24}Na$ content of the plasma that the patient received a neutron dose of ~2200 rad and a $\gamma$-ray dose of 6600 rad, or a total whole-body dose of 8800 rad. It is thus apparent that no known form of therapy would have been effective in saving his life. The central problem was failure of the circulation. Not only was there failure to maintain an adequate blood pressure, and unsustained response to vasopressor agents, but also there was evidence of dilatation of the right side of the heart and venous congestion. It is suggested that circulatory failure was due to vasoactive peptides released as a result of radiation-induced cell destruction. Cell destruction was indicated by the findings in bone marrow and the rise in uric acid and transaminase in the blood. There is a possibility that the shock was neurogenic in origin. Failing vision, restlessness, and delirium in this patient suggested neurologic damage but could have been due in part to other circumstances. There were gastrointestinal symptoms but no evidence of bleeding. The lymphocytes disappeared from the blood, and the bone marrow was virtually destroyed, but the patient succumbed before bone-marrow failure had much reflection in the red cells or granulocytes of the peripheral blood. Thus, whereas the patient showed the usual manifestations of the acute radiation syndrome, the principal features were in the cardiovascular system. Management of this victim of a nuclear accident imposed a great problem in radiation safety. He had heavy surface contamination of radiation-emitting isotopes; furthermore, vomitus, sweat, urine, and feces were all contaminated with $^{24}Na$ and $^{32}P$. Thus, there was the problem of radioexposure to the personnel caring for the patient, as well as the disposal of contaminated clothing, linen, and radioactive excreta. Three other employees were found to have been exposed to 30 to 50 rad of whole-body radiation during clean-up operations. These three exposed persons have been kept under close medical supervision since the accident, but no overt evidence of radiation damage has appeared. Hospital administrative problems that arose in this incident are also discussed. (BBB)

**31859** STUDIES ON THE PRODUCTION OF BUD SPORTS IN TULIPS BY IONIZING RADIATION. V. EFFECTS OF TOTAL DOSE, FRACTIONATION, AND TEMPERATURE ON SOMATIC MUTATION. Nezu, Mitsuya (Toyama Agricultural Experiment Station, Japan). Nippon Idengaku Zasshi, 39: 440-6(Dec. 1964). (In Japanese)

In tulip flowers developing in the bulb during storage, color spots on the perianth were induced by $\gamma$ irradiation. After irradiation during the critical period shortly before the completion of perianth formation, the color spots appeared at random in one or a few epithelial cells. The extent of mutation was reduced at low intensity as compared with high intensity exposure. Therefore, the spots are considered to be due to somatic mutation of epithelial cells, caused by chromosomal deletions due to irradiation. To elucidate the nature of the genetic change, quantitative studies of total dose, fractionation, and temperature effects on the somatic mutation were studied. Since the data are based on the number of mutant cells per unit area, growth inhibition of the perianth was undesirable. Measurements on the size of perianth showed only very rare inhibition after irradiation by a 200-R total dose in October. Cell division of the epithelium at the time of irradiation, in October and November, was estimated from the average number of mutant cells per spot, which was 1.13 and 1.02 at 200 R, respectively. This indicates that the epithelial cells of the perianth do not undergo division after November. Frequency of color spot occurrence after single acute exposure was examined at doses of 25 to 200 R at 600 R/hr. The dose-response curve was of exponential type. The effect of a total dose of 100 or 200 R fractionated into two or four doses of 50 and 100 R, respectively, at intervals of 30 to 1440 min was compared with that of single dose. No reduction of mutation was observed when the interval lasted 30 min, whereas with fractionation into four doses at the same interval, the number of mutations was reduced compared with a single dose. When the interval lasted 1440 min at the total doses of 100 and 200 R, the number of mutations increased at low temperature (–2° to 2°C) during irradiation compared with that obtained at 12.5°C. These results show that chromosome

reunion after deletion may be involved in the color spot formation induced by γ rays. (BBB)

**31860** STUDY OF PLATELET RESPIRATION BY RAPID AND SENSITIVE MEASUREMENT OF OXYGEN CONSUMPTION. Servoz-Gavin, M.; Hollard, D. (Centre d'Etudes Nucleaires, Grenoble, France). Nouvelle Rev. Franc. Hematol., 4: 699-700(Sept.-Oct. 1964). (In French)

A technique was specifically developed to measure the oxygen consumption of irradiated platelets. No results are given. (BBB)

**31861** PULMONARY LESIONS APPEARING AFTER LARGE DOSES OF IONIZING RAYS. Margineanu, N. (Inst. of Medicine, Timisoara, Rominia). Oncol. Radiol., 3: 333-8(1964).

Injury of the lung may occur after the administration of large doses of ionizing rays, as used in the treatment of malignant tumors of the thoracic organs. When a dose of 4,000 to 5,000 R administered in the central part of the lung, the lesions are as a rule reversible, whereas after the administration of 7000 to 8000 R irreversible lesions appear. Five cases of fibrosis are described, and it is pointed out that mistakes are often made in the diagnosis because the physician considers the roentgenological changes to be due to the presence of the malignant tumor and continues to apply roentgen therapy which is actually detrimental to the patient. (Excerpta Med., Sec. XXIII, 2: No. 4, (Apr. 1965))

**31862** LEUKEMIA IN ICELAND 1957 TO 1961. Magnusson, S. (Univ. Hospital, Reykjavik, Iceland). Pathol. Microbiol., 27: 705-7(1964).

An estimate was made of the incidence of leukemia in Iceland and of the possible etiologic role of prior exposure to ionizing radiation. Data covering the years 1957 to 1961 inclusively show the incidence of and mortality from leukemia in Iceland during that period. There were 57 deaths from leukemia, which thus accounted for 1% of the total deaths (5979) and 4.3% of deaths from malignant diseases. The yearly death rate from leukemia was 6.7 per 100,000. Acute leukemia, chronic myelogenous leukemia, and chronic lymphatic leukemia accounted respectively for 64.9%, 12.3%, and 22.8% thus conforming in general to reported figures from other countries, as does the age and type distribution. The preponderance of males to females was 2.56 : 1, acute leukemia accounting for most of the male preponderance. It was concluded that 5 patients may well have had radioinduced leukemia. (TCO)

**31863** GENERAL STUDY OF THE GEOGRAPHY OF LEUKEMIAS. Bernard, J. (Hopital Saint-Louis, Paris). Pathol. Microbiol., 27: 708-22(1964). (In French)

Extensive studies have been made of the leukemias induced by radiation from the atomic bomb in Japan. Statistics from Hiroshima and Nagasaki confirmed the belief that leukemias induced by radiations were similar to serious blood disorders of radiologists and physicians. The relation between the dose received, or distance from the blast site, and the frequency of leukemias has been determined. The initial stages of leukemia have, in certain cases, been outlined. It has not been determined if radiations are responsible for a particular form of leukemia. The reasons for the sensitivity of some Japanese to radiations and the resistance of others remain unknown. It has been suggested that there are several classes of children which should be examined for leukemia. Children who have undergone repeated transfusions or a total transfusion at birth might have received a leukemogenic agent. This does not seem likely. Children who respond to infections with persistent lymphocytosis may develop leukemia. It is believed that hyperallergism is sometimes an antecedent of leukemia. Classmates of a leukemic child should be checked, as there are a few examples of minor epidemics in schools. The role of radiations in leukemias can be examined with the aid of geography in three ways: study of Japanese radioleukemias, study of leukemic frequency in relation to medical and industrial uses of radiations in a country, and a study of the role of natural radiations. Where natural radioactivity is strong, the population should be studied as a function of the average radiation dose received, the leukemigenic dose, and the natural incidence of leukemias. Important factors to be considered are: variations concomitant with exposure to external and internal sources of radiation, equal distribution of demographic characteristics in the study and control groups, types of leukemias found, and homogeneity of the population's exposure to radiations. (BBB)

**31864** THE DIFFERENTIAL CAPACITY FOR RNA SYNTHESIS AMONG CHROMOSOMES: A CYTOLOGICAL APPROACH. Klevecz, Robert R.; Hsu, T. C. (Univ. of Texas, Houston). Proc. Natl. Acad. Sci. U. S., 52: 811-17(Sept. 1964).

The breakage of chromosomes in diploid cell cultures of Chinese hamsters (strain Don) by 220-kv x rays and by $^3H$ in labeled thymidine (TdR) and uridine (UR) was studied. The frequency of breaks in $G_2$ populations rose sharply as the concentration of $^3H$-UR increase, but leveled off at 48 breaks per 100 cells at 50 μC/ml of $^3H$-UR. At this concentration breaks were too numerous to allow localization, and for subsequent experiments a concentration (20 μC/ml) which gave half as many breaks was chosen. Uridine is not incorporated into DNA in $G_2$ cells; in this phase $^3H$-TdR also produced little damage to the population. Conversely, in the early S population the break frequency was $^{65}/_{100}$ cells, indicating an active use of the tritiated precursor. Contrary to the drastic differences among populations treated with $^3H$-TdR, the frequency of breaks induced by $^3H$-UR remained relatively constant throughout the cell cycle, although a decrease in early S and an increase in $G_1$ were noted. Distribution of breaks along each chromosome following $^3H$-TdR and $^3H$-UR treatments was found to be nonrandom in all experiments. The distribution of x-ray-induced breaks was also random. The breakage patterns in late and early S following $^3H$-TdR treatment exhibited some complementarity. It is concluded that x irradiation produces random breakage, both along individual chromosomes and between different chromosomes. Tritiated thymidine induces damage when a chromosome segment replicates; otherwise the damage is negligible. Tritiated uridine induces nonrandom damage, which occurs primarily at early DNA replicating sites. (TCO)

**31865** FACTS AND FALLACIES OF IONIZING RADIATION. Deutschberger, Otto. Proc. Rudolf Virchow Med. Soc. City N. Y., 22: 1-24(1965).

Attempts are made to clarify some confusing and controversial views pertaining to the harmful effects of ionizing radiation, especially as it is used in medical diagnosis and therapy. The acute and chronic effects on human tissues of radiation exposure at various dose levels are reviewed. Late effects, such as genetic damage, carcinogenesis, leukemogenesis, and life shortening are also considered. Carcinogenesis may be the sequelae of local tissue damage and may occur after acute or chronic radiation. Carcinoma of the skin may develop four to fourteen years after the first onset of x-ray injuries. With the awareness of these damages, complete protection has been elaborated and any occurrence of radiation cancer can only be contributed to carelessness, negligence, or ignorance. The doses responsible for the development of malignancies are enormous, as shown in a table. The occurrence of leukemia due to radiation is a well-established fact, but it can be completely averted when effective protection is employed. Protection against chronic total body radiation can now be considered complete although it was not adequate ten years ago. Up to 1944 the incidence of leukemia in physicians who worked with ionizing radiation was ten times higher than that for physicians working in other fields of medicine. More recent statistics in the United States (1945 to 1958) reveal that death from leukemia is still six times more frequent in radiologists than in other physicians, but with modern protection and education this rate will be lowered further. Since the absolute number of leukemia cases caused by radiation is very small, this condition obviously

does not develop in every person in spite of appreciable exposure. This supports the hypothesis that ionizing radiation triggers leukemia only in persons with a disposition for this disease, much as bronchogenic carcinomas do not develop in every heavy smoker. It is, however, problematic as to how small a dose may trigger carcinogenesis or leukemogenesis in susceptible persons. Some biologists who applied experimental total body radiation to small animals deny the existence of a threshold dose. If this were true, any ionizing radiation, however small, would be fully accumulated and no recovery could take place. Recovery of tissue, however, has been demonstrated by the greater tolerance of a fractionated dose. Therefore, if the single dose is small enough and extended over a sufficiently long period of time, the biological effect remains zero. Experiments on mice with small fractionated dosages suggest that a threshold dose does exist. Although recommendations for observing the threshold dose as a safeguard against the hazards of ionizing radiation are justified, they have produced many misunderstandings. There is a tremendous discrepancy between the threshold dose and the dose used in medicine, particularly in therapy. Some doses absorbed by patients during diagnostic radiology are reviewed and attempts made to evaluate the hazards involved in terms of recommended minimum acceptable doses. Figures are used to demonstrate the exit doses of diagnostic as well as supervoltage or $^{60}$Co radiation for a layer of 25 cm corresponding to the thickness of a human trunk and for a layer of 2 cm corresponding to the body of a mouse. In contradistinction to diagnostic radiation with an exit dose of 0.36% for a layer of 25 cm, supervoltage or cobalt radiation reveals an exit dose of 30% of the entry dose for the same thickness of layer. The same type of radiation administered to a mouse shows that 88% of the entry dose penetrates to the opposite surface. The entry dose in diagnostic radiation for man is $\frac{1}{20}$th of the threshold dose. Comparison of this entry dose to the lesser thickness of the layer of a mouse shows that it becomes about three times the permissible tolerance dose. Special consideration is given to fluoroscopy where the examiner is close to the x-ray tube and is exposed to radiation. Although through improved fluoroscopes and proper protection, the average exposure has been reduced 96% of that received 30 years ago and can be kept far below the permissible threshold dose, there still exists an unwarranted fear among physicians. The output of fluoroscopes has been reduced through technical advances to 10 or 12 R/min. Thus, a fluoroscopy of two to five minutes renders only 20 to 60 R skin dose at the point of entry. No well-trained fluoroscopist uses the entire screen area throughout the entire examination. Instead, by narrowing and shifting the field of vision, the exposure reaching any given area of the patient is drastically reduced. Since each field of vision covers about $\frac{1}{6}$ of the thorax area, it follows that the exposure time for the point of entry is also reduced to $\frac{1}{6}$. For this reason the actual skin dose per field varies from 3 to 4 R for a chest fluoroscopy of two to two and a half min. The entry dose for a fluoroscopy of the upper gastrointestinal tract amounts to 15 R. Ionizing radiation has been held responsible for shortening the span of life, and it is true that dosages producing irreparable damages in important organs and impairing their functions may eventually cause premature death. Without tissue damage, however, there is no evidence that radiation reduces longevity either by accelerating the process of aging throughout life or by hastening the onset of senescence. It is concluded that is is not possible to translate and evaluate the results of animal experiments directly to man. A man is not a mouse multiplied in size, life span, and other biological characteristics. Therefore, with all experimental findings, although the integrity of the researchers need not be doubted, their conclusions must be interpreted with caution. (BBB)

**31866** PROGRESS IN LEUKEMIAS. Clarkson, Bayard D.; Burchenal, Joseph H. (Cornell Univ., New York). Progr. Clin. Cancer, 1: 625-63(1965).

Recent advances in various aspects of leukemia research are reviewed, including the role of radiation exposure in its etiology and use of radiation in its treatment. Although the etiology of most cases of human leukemia remains unknown, the three major factors known to influence leukemogenesis in man are ionizing radiation, heredity, and chemical carcinogens. Excessive radiation exposure appears unequivocally to cause an increased incidence of leukemia. Based on the appearance of leukemia in survivors of the atomic bomb explosions in 1947 in Nagasaki and Hiroshima, the incidence was roughly linear according to the dose received above about 100 rad. The over-all incidence was one to two cases per rad per million population per year for doses of 100 rad or greater, or about five times that expected to occur spontaneously. The increase in leukemia was greater in young than older persons; in the former, the increase was due to acute leukemia, and in adults to both acute leukemia and chronic myelogenous leukemia. Leukemia has also occurred with increased frequency in persons receiving chronic or protracted exposure to radiation. These include patients receiving x-ray therapy for spondylitis and a variety of other conditions, infants treated with x rays for thymic enlargement, radiologists and other persons having occupational exposure, and patients given Thorotrast or $^{131}$I. The significance of chromosome abnormalities to radioleukemogenesis is also discussed, and the use of whole-body radiation and marrow transplantation in treatment of leukemia is reviewed. (TCO)

**31867** EFFECTS OF ULTRA-VIOLET LIGHT ON THE SURVIVAL AND NUCLEAR DIVISION OF DINOFLAGELLATE. Dodge, J. D. (Birkbeck Coll., London). Protoplasma, 59: 485-93(1965).

Clonal cultures of Prorocentrum micans (strains 7A and 7E) were uv-irradiated in sea water. The survival curve showed the normal exponential relation between survival and dose which has previously been obtained for many microörganisms. Five-min exposure to uv scarcely affected the cells and the normal type of growth curve was obtained, with the logarithmic phase giving way to a more or less stationary phase after about one week. After a dose of 15 min there was a delay of several days during which time no divisions took place but then the cells increased in number and eventually achieved a total only slightly lower than that reached following the five-min dose. In material exposed for 30 min for the first few days there was a rapid decline in cell numbers, followed by a small increase as a few cells divided, but eventually most died and after 24 days the survivors represented only 8% of the original irradiated population. Percentage of cells in mitosis decreased with dose. Percentage of cells exhibiting abnormal divisions of the chromosome bridge type was similar for all doses and there was not a great increase with dose as happened after x-ray treatment. The totals of abnormal divisions (bridges and cleavage failures) increased slightly with dose. Irradiation of Prorocentrum with uv produced chromosome aberrations in a small percentage of cells. At the anaphase following treatment the aberrations were observed as either chromosome bridges or fragments. The bridges were composed of two or four closely associated chromosomes. No single chromosome bridges and no fragment bridges were discovered. From the fact that pairs of chromosomes were apparently involved in all the bridges it is likely that the original aberration, which made possible the chromosome exchange seen as a bridge, was of the chromosome break type. If chromatid breaks occurred these should give rise to single chromosome bridges. Chromosome fragments were found occasionally, and invariably had one end drawn out as a tail suggesting that they were often the remaining part of a chromosome bridge which had been broken by the tension applied during anaphase. Prorocentrum cannot be grown in a defined medium so it has not been possible to screen for biochemical mutants. However, certain morphological changes apparently resulting from the effects of the irradiation were observed, generally in the form of gross aberrations which prove lethal, the cell being unable to divide again. One nonlethal mutant was observed; it

appeared months after a culture was treated with the sublethal dose of 30 min irradiation. Of the surviving population five months after this irradiation 17% of the cells was found to have a form with the right anterior corner of the cell missing. Cytologic examinations showed that the nucleus was normal and no gross chromosome aberration could be seen. (BBB)

**31868** GENETICS AND IONIZING RADIATION. Mountain, Geoffrey H. (Hillingdon Hospital, Middlesex, Eng.). Radiography, 30: 207-12(Aug. 1964).

Some basic principles of genetics and the effect of ionizing radiations upon heredity are discussed. Gene mutation occurs in normal circumstances at a relatively low but constant rate. A large part of the normal level of gene mutation is probably caused by ionizing radiations in the environment, the so-called natural background level. It is made up of the sum of cosmic radiation from space, radiation from naturally occurring elements (such as minute quantities of U which appear in granite), traces of Rn in the atmosphere, and the normal radioactive elements present in the body. Certain chemicals are known to increase the rate of genetic mutation. It is estimated that in the United Kingdom diagnostic radiology is responsible for raising the total gonad dose to the population by 14% above the natural background level of radiation. Diseases caused by mutant genes are considered, with reference to examples. (TCO)

**31869** CLINICAL AND BIOLOGICAL VIEWPOINTS ON THE RADIATION TOLERANCE OF BRAIN TISSUE. Berg, N. O.; Hakansson, C. H.; Lindgren, M. (Univ. of Lund, Sweden). Radiologe, 4: 194-200(June 1964). (In German)

The functional and morphological reactions of brain after after x irradiation are reviewed. Several early reactions can be observed objectively. One of these is the alteration that appears in the level of the cerebrospinal fluid pressure in the lateral ventricles during the first months after irradiation. After irradiation with 300 to 400 R headaches can be noted subjectively, but these do not seem to be related to any changes in intraventricular pressure. Changes in the electroencephalogram curves are observed within a week after initiation of irradiation treatment with daily doses of from 200 to 400 R. Brain necrosis may be induced by fractionated doses of between 4250 to 4500 R/30 days. Doses greater than this increase the incidence of brain necrosis progressively in a manner described by an S-form curve. Studies in rabbits indicate that specific irradiation lesions may be induced by irradiation with single dosages of 5000 to 18,000 R, where the severity and localization of injury observed varies with the direction and size of the irradiation beam used. Radionecrosis of brain might also result indirectly from primary vascular injury within the brain. (BBB)

**31870** THE ACID AND ALKALINE PHOSPHATASES IN SOME ORGANS OF MICE SUBJECTED TO WHOLE-BODY X-RAY IRRADIATION. Muto, V.; Lombardi, S.; Crocco Egineta, M. (Universita, Naples). Rass. Med. Sper., 10: 415-24(1964).

Alkaline and acid phosphatase activities were studied in mouse kidney, spleen, liver, heart, brain homogenates, after a single total body x-radiation, of 1.000 R. In general, both phosphatases reached a maximum on the 3rd day, returning to normal values within the 12th, with variations depending on the tissue. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31871** MIGRATION OF MEDULLARY HEMATOPOIETIC CELLS IN IRRADIATED AND NORMAL MICE. Tubiana, M.; Frindel, E.; Kozinetz, G. I.; Dalle-Chavaudra, N. (Inst. Gustave-Roussy, Villejuif, France). Rev. Franc. Etudes Clin. Biol., 9: 742-5(1964).

Labeled thymidine was injected into mouse limbs cut off from the general circulation by tourniquet. Several hours after release of the circulation, labeled cells were found in bone marrow in other sites of the body. This result was seen in animals with local aplasia due to partial irradiation as well as in normal animals, suggesting migration of marrow hematopoietic cells. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965)).

**31872** CHANGES INDUCED IN RAT LIVER, 4-19 MONTHS AFTER PARTIAL IRRADIATION OF THE ORGAN. (CONSEQUENCES OF IRRADIATION OF THE CHOLEDOCHUS). Lacassagne, Antoine; Hurst, Lucienne (Institut du Radium, Paris). Rev. Franc. Etudes Clin. Biol., 10: 198-211(Feb. 1965). (In French)

Changes produced in the rat liver between the 4th and 19th month after x-irradiation (4,000 R) of the exteriorized median and left lobes are described. (H.G.D.)

**31873** CARCINOGENESIS. II. BY RADIATIONS. Mathe, G.; Amiel, J.-L. Rev. Praticien, 13: 1077-84 (Apr. 1, 1963). (In French)

A review is presented on the usual types of malignancies produced by radiations: skin cancer, leukemias, hematosarcomas, and endocrine cancers. (TCO)

**31874** DELAYED LESIONS AFTER USE OF THOROTRAST. Braband, Heinz (Strahlenabteilung des Staedt. Auguste-Viktoria-Krankenhauses, Berlin). Roentgen Bl., 15: 399-402(Dec. 1962). (In German)

Injuries from prior use of Thorotrast as an angiographic contrast medium were observed in three patients. The first patient, who had received Thorotrast in 1943 for carotid angiography for a suspected subdural hematoma, suffered from persistent neck pains. When examined in 1958 for recurrent paresis the radioactivity in the neck region was three times that of general body background. Thorotrast was detected in the soft parts of the left side of the neck, extending from the region of the occiput to the mastoid process, downward to the clavicle, the mediastinum, and the aorta. The second patient had been given Thorotrast in 1949 for carotid angiography for a suspected brain abcess, associated with otitis and mastoiditis. In 1958 the patient, with bronchial carcinoma, reported chronic stiffening and hardening of the left side of the neck. A thorotrastoma was detected in this region, which was radioactive. The third patient had undergone left femoral arteriography in 1944 because of peripheral circulatory disturbances and intermittent claudication. In 1959 the patient was studied by means of x ray. The results showed deposits of Thorotrast medially and dorsally in the leg at the level of the proximal femur shaft. These areas were ~20 × 4 cm in breadth. There were also diffuse depositions of Thorotrast in the patient's spleen and throughout the para-aortal lymph nodes. The patient developed polycythemia vera, but it was not possible to demonstrate any causal relation of this disorder to the thorotrastosis that was concurrently present. (BBB)

**31875** RADIATION RESISTANCE IN LIPOVIRUS-ALTERED HUMAN CELLS. Little, John B.; Chang, R. Shihman (Harvard Univ., Boston). Science, 148: 1746-7 (June 25, 1965).

Human cells altered by infection with the lipovirus, a transmissible cytopathic agent, are highly resistant to ionizing radiation. Whereas about 500 Roentgens will inhibit cell multiplication in normal cells, more than 500,000 Roentgens are required to produce a similar effect in the altered cells. This gross change in cellular radiosensitivity may provide a useful system for studying in vitro the mechanisms of inhibition of cell division by radiation. (auth)

**31876** ULTRAVIOLET IRRADIATION OF NUCLEIC ACID AND RELATED SUBSTANCES. Ishihara, Hiroshi (Nagoya City Univ., Japan). Seikagaku, 35: 753-74(Nov. 1963). (In Japanese)

The photochemistry of nucleic acids and related compounds with respect to ultraviolet radiation is reviewed. The photochemistry of pyrimidine salts, nucleotides, and nucleosides is discussed along the lines of the irradiation of aqueous solutions and dimerization reactions. Of particular interest is the irradiation of frozen solutions, thin films, and microcrystals. Ultraviolet irradiation studies

of oligonucleotides, synthetic polynucleotides, and nucleic acids are described. The subject of photo-reactivation is discussed particularly with respect to DNA type compounds. Some examples of biological applications of ultraviolet irradiation are cited. These include establishing the structure of 3,5-diribocil uracil, spectrophotometric orcine determination of uradine and uradylic acid, determination of uradine and uradylic acid, determination of the arrangement of nucleotides, and determination of the coding of protein compounds. (TTT)

**31877** STUDIES ON THE PRODUCTION OF BUD SPORTS IN TULIPS BY IONIZING RADIATION. III. FREQUENCY AND MECHANISM OF COLOR SPOT FORMATION. Nezu, Mitsuya (Toyama Agricultural Experiment Station, Japan). Seiken Jiho, 15: 75-86(Dec. 1963). (In Japanese)

In tulips, which propagate regularly by bulbs, color spots of the perianth can be readily induced by irradiation. The relation between size of color spots, bud differentiation, and spot frequency in successive vegetative generations after $\gamma$ irradiation was examined, and to elucidate the mechanism of color spot formation, and relation between color spots and dose (or dose rate), with special reference to chromosome aberrations, was studied. These results showed that the mutation rate was not reduced in successive vegetative generations after irradiation. The percentage of abnormal cells increased with increasing dose at 50 to 1000 R in total dose, and the induction rate per R was calculated to be 2 to $4 \times 10^{-4}$. The frequency of color spots or mutated cells increased according to a saturation curve within the same dose range, and the mutation rate per R was 2 to $5 \times 10^{-5}$. Mutation rate per R of color spots increased with dose rate from 17.5 to 200 R/hr at 200 R. On the basis of these results and the fact that color appeared in single epithelial cells when the irradiation was carried out in the period of perianth tissue formation, it is suggested that the mechanism of spotting in tulip flowers after irradiation may be due to damage of genetic materials, probably deletion of chromosome fragments. (BBB)

**31878** ON THE DISTINCT EFFECTS OF THE SAME RADIATION DOSES FOR DIFFERENT TIME DISTRIBUTIONS ON THE ROOT END MITOSIS OF VICIA FABA. INVESTIGATIONS OF THE PROBLEMS OF INCREASES IN TUMOR SELECTIVITY BY AN EXPONENTIALLY DECREASING LONG-TERM IRRADIATION. Kapp-Schowerer, Hermann; Witzel, Lothar (Universitats-Frauenklinik, Freiburg i. B.). Strahlentherapie, 127: 87-106 (May 1965). (In German)

Mitosis in Vicia faba was investigated as a function of exponentially decreasing long term irradiation ($^{198}$Au-seeds), continuous long term irradiation (radium), and fractionated x ray irradiation. The technique is reported and a graphical representation of the results is given. With higher doses greater damage was obtained using exponentially decreasing long term irradiation than by the other two types of irradiation. With smaller doses a reversal of the radiation effect was observed. (tr-auth)

**31879** THE ELECTROPHORETIC MOBILITY OF RABBIT SPERM AFTER X IRRADIATION OF THE TESTES. Ruhenstroth-Bauer, Gerhard; Hertel, Eckard (Max-Planck-Institut fur Biochemie, Munich). Strahlentherapie, 127: 107-11(May 1965). (In German)

A gradual increase in electrophoretic mobility of normally ejaculated sperms was observed 5 days after selective x irradiation of rabbit testes with 400 R. This increase persisted for 3 to 5 weeks, and was followed by a gradual return to normal. This effect is not a sudden event, since only small scatters were observed during the complete time period. No change was observed when the urogenital tract was irradiated with the testes protected. No decrease in the electrophoretic mobility of irradiated rabbit testes sperms was observed after incubation with normal seminal plasma. In vitro irradiation of rabbit sperms with 600 to 1000 R had no effect on their electrophoretic mobility. (tr-auth)

**31880** INFLUENCE OF CONTINUOUS INTRAUTERINE IRRADIATION ON PRE-NATAL MORTALITY OF THE EMBRYO. Vorisek, Premysl (Anstalt fur Mutter- und Kinderfursorge, Prague). Strahlentherapie, 127: 112-20 (May 1965). (In German)

The influence of small chronic doses of gamma rays on intrauterine development of the fetus and the course of the pregnancy is reported, after a short literature survey of fetal mortality after irradiation in utero. A $^{60}$Co-radiation field, with a continuous daily dose rate of 2.5 R, was obtained by using a special irradiation device. The following observations were made: Chronical irradiation did not change the mean duration of pregnancy. There was no difference in the mean weight gain between the pregnant irradiated rats and the control animals. There was a disturbance of the pregnancy at the 11th day during the period of placentation in 5% of the irradiated rats. The irradiated rats showed a high relative prenatal mortality of 21.5%. There was no significant influence of the chronic irradiation upon the neonatal mortality. The postnatal mortality of animals born alive was significantly higher than in the control animals. There were no morphological changes in the irradiated fetuses. (tr-auth)

**31881** INVESTIGATIONS OF THE PRODUCTION AND METABOLISM OF CORTICOIDS AFTER LETHAL WHOLE-BODY IRRADIATION OF GUINEA PIGS. Winkler, Cuno; Schorn, Heinz (Chirurgische Universitatsklinik, Bonn). Strahlentherapie, 127: 121-8(May 1965). (In German)

Knowledge concerning the production rate and metabolism of the corticoids is necessary in order to judge their pathophysiological importance during the acute radiation syndrome. Experiments were done with glucocorticoids in lethally irradiated guinea pigs. By means of $^{14}$C-labeled cortisol and chromatography, it could be shown that there is a large increase in adrenal cortisol production as well as considerable changes in cortisol metabolism during radiation sickness. Enzyme mechanisms, which are responsible for these phenomena, and consequences for therapy, are discussed. (tr-auth)

**31882** STUDIES ON THE NITROGEN METABOLISM IN FROG LIVER AFTER WHOLE-BODY IRRADIATION. II. TIME- AND DOSE-DEPENDENCE OF NITROGEN EXCRETION FROM ISOLATED FROG LIVER AFTER WHOLE-BODY IRRADIATION. Antonijevic, Milos; Lebez, Drago (Nuclear Institute "Jozef Stefan," Ljubljana, Yugoslavia). Strahlentherapie, 127: 129-32(May 1965).

The time- and dose-dependence of the nitrogen excretion in frog livers was studied. Pronounced differences were observed between time-course of the liver nitrogen excretion of frogs irradiated with 400 R and 650 R. With the lower dose the nitrogen excretion reached maximum value when the perfusion was started 24 hours after whole-body irradiation. Higher level of the excreted nitrogen was observed after the dose of 650 R with the maximum value obtained if the organ were isolated 10 hours after exposure. (tr-auth)

**31883** THE EFFECT OF ULTRAVIOLET RAYS ON THE FIXATION OF P$^{32}$ IN THE LIVER AND SKIN OF RATS AND FROGS. Pora, E. A.; Ghircoiasiu, M. Studia Univ. Babes-Bolyai, Ser. Biol., No. 1, 111-16(1963).

After 16 days of exposure to ultraviolet light white rats, shaved and unshaved, were given a dose of $^{32}$P. Except for irradiation, controls were treated identically. After 24 hours the animals were sacrificed and determinations were made in the liver and skin of the following phosphorus fraction: acid-soluble P, lipid P, and P in the nucleic acids. The acid-soluble P and the lipid P increased in the skin, whereas nucleic acid P decreased, in shaved and unshaved animals. In the liver of the irradiated animals all phosphorus fractions increased. A similar result was obtained in frogs. In rats with intact fur the changes were more marked than in shaved rats. (Excerpta Med., Sect. XXIII, 2: No. 4 (Apr. 1965))

**31884** CHROMOSOMAL STUDIES ON HUMAN LEUCOCYTES FOLLOWING TREATMENT WITH RADIOACTIVE

IODINE IN VIVO AND IN VITRO. Oishi, H.; Pomerat, C. M. (Pasadena Foundation for Medical Research, Calif.). Symp. Intern. Soc. Cell Biol., 3: 137-54(1964).

The effects of diagnostic doses of radioiodine were examined on the chromosomes of two normal individuals. Data are also provided on the chromosomes of leucocytes from nine patients who received therapeutic doses for hyperthyroidism. Although it was difficult to make a quantitative comparison of chromosomal anomalies because of the many variables involved, it was possible to appraise values for leucocytes before and after therapy in particular individuals. To compare in vivo with in vitro effects of diagnostic and therapeutic doses, an attempt was also made to study the chromosomal patterns of leucocytes examined after the addition of $^{131}I$ to cultures. Chromatid breaks or a terminal deletion of a chromatid arm (chromatid deletion) were observed in 7 out of 9 cases. These were counted more frequently in the samples after therapy than before treatment with $^{131}I$. Tetraploid cells were observed in two cases. One of two cases for which a third sample was obtained more than 100 days later showed a lesser degree of damage. Dicentric chromosomes were observed in three cases from samples after therapy, and chromosomal translocations were also found in two samples after therapy. Thus, the overall percentage of chromosomal aberrations for this series ranged from 0 to 12 before and from 2.7 to 51.9 after therapy. No correlation between the postirradiation effect and any other variable was seen. Chromosomal observations were performed on human leucocytes 72 hours after irradiation with $^{131}I$ in vitro. The predominant chromosome number was 46 in all cases. Chromatid aberrations were counted in two groups, as well as chromatid deletions and breaks. Fragments and chromosome breaks (isochromatid breaks) were also noted, as well as dicentrics in two experiments. Two mitoses were found which had 8 and 23 chromosomes, respectively, but no tetraploid cells were observed. When cells were treated with 1.0 $\mu$C $^{131}I$/ml for 3 hr, the large-size cell number was reduced; yet the number of metaphases showing marked stickiness or clumping increased noticeably. After treatment with 2.0 $\mu$C $^{131}I$/ml, mitotic figures were very rare in the preparation and showed small-size cells. (BBB)

**31885** PRESENT TRENDS IN RADIATION IMMUNOLOGY. Petrov, R. V. Usp. Sovrem Biol., 58: 262-71(Sept-Oct. 1964). (In Russian)

A state review is presented on the use of cell cultures in vivo, immunology of radiation chimeras, control of transplants, and contributions to theoretical immunology. (IIC-M.G.)

**31886** BASES OF EMBRYONIC PATHOLOGY. Thalhammer, O. (Universitaets-Kinderklinik, Vienna). Wien. Klin. Wochschr., 76: 1-4(Jan. 3, 1964). (In German)

Susceptibility of the embryo to radiation injury is closely related to time of irradiation. As shown by studies in rats, starting at about the tenth day after implantation the damage caused by irradiation becomes more and more frequent. The type and degree of irradiation damage appears to be associated with periods when the susceptible tissues are undergoing differentiation. However, the susceptible time period is also dose dependent. The greater the irradiation dose, the more the period of radiosensitivity is extended. Also, different organ systems may vary in their radiosensitivity characteristics both as to time and degree of maximum susceptibility. These differences may appear in differences in the pathological results. Basically, the degree of radiosensitivity demonstrated may indicate destruction or interference with chains of metabolic cellular activities, where specific effects may be exerted on enzymes, coenzymes, etc., by the irradiation. Since many biochemical steps are involved in developmental activities of cells, irradiation may affect any or all of them to greater or lesser extent. The particular sequence of metabolic effects and the degree to which they are involved may produce embryonal defects, and as a consequence developmental malformations. (BBB)

**31887** EXPERIMENTAL STUDIES OF THE FORMATION OF AN ERYTHROPOIETIC FACTOR IN THE KIDNEYS. Andreadis, Paul; Bromig, Georg; Scharz, Joachim (Chirurgische Universitaetsklinik, Frankfurt am Main). Z. Ges. Exptl. Med., 138: 62-72(Feb. 17, 1964). (In German)

Frequently severe chronic pyelonephritis is accompanied by anemia which is difficult to treat. Previous studies have suggested that this anemia is due to lack of an erythropoietic substance secreted by the kidney. In severe kidney disease the kidney may not be able to supply this factor. To study this, rabbit kidneys were irradiated with 14,000 R of 35-Mev electrons, administered over 3 or 4 weeks in single doses of from 500 to 1000 R. Excretory function was retained in these animals. Serum containing erythropoietin from an unirradiated rabbit was administered to the irradiated rabbits, and a marked erythropoiesis was observed. This was confirmed by histologic studies of the bone marrow. Hemoglobin and erythrocyte concentrations increased within 24 to 48 hr. The results suggested that the anemia which accompanies severe chronic pyelonephritis could be treated by administration of serum that may contain an erythropoietic factor. (BBB)

**31888** EFFECTS OF STORING X-RAYED SPERMATOZOA ON THE FREQUENCY OF TRANSLOCATIONS AND SEX-LINKED LETHALS IN DROSOPHILA MELANOGASTER. Khishin, Aziz F. E. (Inst. of Animal Genetics, Edinburgh). Z. Vererbungslehre, 94: 280-4(Nov. 21, 1963).

When Drosophila spermatozoa which have been treated with an alkylating agent are stored in the seminal receptacles of females, the frequency of translocations rises strikingly, while that of the sex-linked recessive lethals either does not change or increases only to the extent expected from the admixture of rearrangements. To compare the effect of ionizing radiation with chemical mutagens, adult Oregon-K (Or-K) males were x irradiated and mated to virgin females of stocks appropriate for testing the frequencies of sex-linked recessive lethals and translocations separately or simultaneously. Tests were made for translocations involving the two large autosomes and either the Y or the X chromosome. Progeny for testing the induced changes was collected over 2 periods: (1) during the first 2 or 3 days following irradiation and prior to storage (prestorage), and (2) after the storage of the inseminated females for a period of 6 days (poststorage). Matings and collection of progeny was done on the usual maizemeal molasses medium. The results of two experiments in which both sex-linked lethals and translocations involving the chromosomes Y, 2, 3 were studied simultaneously, and in two more experiments where sex-linked lethals alone were tested for, showed that the frequency of x-ray induced sex-linked lethals was not changed by storage. Translocation frequencies involving the Y, 2, 3, chromosomes showed a consistent though slight enhancing effect on storage. When translocations involving the X chromosome and the two large autosomes were studied, there was no increase in their frequencies after storage. This suggests that the slight increase observed in the Y, 2, 3, translocations series was due to the inclusion of the Y chromosome. However, a study of the percentages of Y, 2, 3, translocations among tested spermatozoa, showed that this cannot be the whole explanation. In the experiments where 2 or 3 translocations as well as translocations involving the Y chromosome were scored, both types increased after storage. The increase was more pronounced for the Y translocations, but the increase was significant at the 5% level for both types. It is concluded that the strong storage effect on translocations produced by certain alkylating agents is peculiar to chromosomes treated by these chemicals, and must be related to the way in which they cause chromosome breaks. (BBB)

**31889** STUDIES ON THE RATE OF SPERMATOGENESIS IN DROSOPHILA: EFFECTS OF X-RAYS AND STREPTONIGRIN. Martin, Alice O. (Univ. of Michigan, Ann Arbor, Mich.). Z. Vererbungslehre, 96: 28-35(1965).

Studies were made to answer two questions: can a

schedule obtained from data about the time required for mutations to appear in functionally mature spermatozoa, when induced by x rays in specific types of cells of the immature testes, have validity in determining the rate of progress of cells of a similar type through spermatogenesis when the mature testis is irradiated; and is the rate of spermatogenesis the same in an x-rayed or chemically treated testes as it is in an untreated testis, so that similar time scales will be applicable? In addition, an attempt was made to elucidate the mechanism of any radioinduced retardation that might occur. The rate of spermatogenesis in adult Drosophila melanogaster was measured by use of tritiated thymidine as a radioactive tracer. A comparison of the results for control and irradiated males revealed indications of a radioinduced lag. The time tables of spermatogenesis stages were identical for the first three broods. However, late spermatids appeared in brood four of the control group, but not until brood five in the irradiated flies. Mature sperm appeared in brood five of the control, but not until brood six of the x-rayed. Primary spermatocytes persisted longer in the streptonigrin-treated samples than in the controls. Also, the progress of cells through spermatogenesis was about 24 hr faster in the adult testis as opposed to that of the immature testis. The results support the suggestion that x rays effect a rate change in the progress of cells through spermatogenesis, as seen by comparison between the control and irradiated adult males. Two sets of evidence (one for larval and one for adult Drosophila) point to a retardation of the rate of gametogenesis induced by x rays. (TCO)

**31890** THE UTILIZATION OF 2-$^{14}$C-ACETATE FOR PROTEIN SYNTHESIS BY E. COLI AFTER X-IRRADIATION. Dose, Kl.; Bresciani, F. (Max-Planck-Institut fur Biophysik, Frankfurt am Main and Universita, Naples). p.109-14 of "EUR-2200.e."

The effects of x radiation, 10 krads to 1 mrad, on the utilization of 2-$^{14}$C-acetate for protein synthesis by Escherichia coli were studied. The dose effect relations for 60 min incubation periods and the dependence of the radiation insult on incubation time after irradiation were determined. The various pathways of $^{14}$C incorporation from 2-$^{14}$C-acetate into amino acids are shown. (C.H.)

**31891** INCORPORATION OF $^{3}$H-PHENYLALANINE INTO SERUM PROTEINS OF NORMAL OR IRRADIATED MICE. Sassen, A.; Reuter, A.; Kennes, F.; Franssen, J. (Centre d'Etude de l'Etude de l'Energie Nucleaire, Mol, Belg.). p.175-8 of "EUR-2200.e."

Mechanisms involved in radioinduced changes in total proteins, albumins, and globulins were investigated in mice and rats after a single intravenous or intraperitoneal injection of l-phenylalanine-$^{3}$H-2-3. Blood was withdrawn at different time periods or the animals were sacrificed and the radioactivity of total proteins and protein fractions from serum and liver was determined. Incorporation of $^{3}$H-phenylalanine into serum proteins of lethally x irradiated rats or mice was found to be increased. Since the pool of free phenylalanine was not decreased in these animals, it was concluded that the higher incorporation reflects a higher synthesis of serum proteins and the modifications of concentration of serum proteins after irradiation could be due to abnormal catabolism, possibly accompanied by intestinal leakage. (C.H.)

**31892** "PRIMER" IN DNA POLYMERASE REACTIONS. Bollum, F. J. (Oak Ridge National Lab., Tenn.). p.1-26 of "Progress in Nucleic Acid Research. Vol. 1." New York, Academic Press, 1963.

Information is included on the priming activity as a function of molecular weight and state, chemical and physical effects as an aid in elucidating mechanism, and hypothetical mechanism for DNA synthesis. (P.C.H.)

**31893** MOLECULAR MECHANISMS OF RADIATION EFFECTS. Wacker, A. (Universitat, Frankfurt am Main). p.369-99 of "Progress in Nucleic Acid Research. Vol. 1." New York, Academic Press, 1963.

The effects of uv and x irradiation on molecular reactions in DNA and their mechanisms are reviewed. The molecules studied thymine, uracil, cytosine, and pyrimidines. (P.C.H.)

**31894** THE EFFECT OF COBALT 60 GAMMA RAYS ON THE BIOLOGY OF THE EYE GNAT, HIPPELATES PUSIO LOEW. Flint, Hollis Mitchell. Thesis, Gainesville, Fla., Univ. of Florida, 1964. 67p.

Work is reported on changes in the life processes of Hippelates pusio Loew brought about by treatment with $^{60}$Co gamma rays. Test insects received approximately 2,500 R per minute and were maintained at 80 ± 2°F and approximately 70 per cent relative humidity. Fertility was assayed by egg hatch. Insects were considered to be sterile when egg hatch was reduced to 1 per cent or less. Sterility tests were made on gnats treated as 24- to 36-hour-old adults and pupae treated 2 days prior to emergence. The sterilizing dose for males treated as adults was 4,550 R and 3,750 R for males treated as pupae. Females required 4,900 R when treated as adults and 4,700 R when treated as pupae. Adult-sterilized males were found to compete normally with untreated males. However, males sterilized in the pupal stage were much less effective in competing for females. A partial recovery of fertility was observed in males 18 days after treatment with 4,500 R as pupae or up to 3,000 R as adults. Female gnats treated in the pupal stage with the sterilizing doses did not lay eggs in the adult stage. However, egg production from females treated in the adult stage was approximately ⅔ that of control gnats. In mortality tests, adults were treated with doses up to 135,000 R, which caused death within 4 days. A dose of 5,000 R showed no effect on the life span of treated adults during a 7-week test period. Pupae were found to be more radiosensitive than adults. Emergence was prevented in ½ the treated pupae by a dose of 12,000 R. Last instar larvae were very susceptible to a dose of 3,500 R as measured by adult emergence. Eggs a few hours old were sensitive to doses as low as 100 R but within 48 hours were able to withstand several thousand R. Examination of ovarian morphology in gnats treated as pupae revealed that growth was inhibited by doses as low as 500 R. The ovary was unable to develop any adult structure after a dose of 4,500 R. Testes from gnats treated as pupae with 4,500 R were retarded in growth but produced motile sperm. Cytological examination of treated testes revealed visible chromosomal abnormalities in pupae and adults treated with 2,500 R. The diploid (2N) chromosome number was found to be 8. Chromosome number determinations were made from untreated larval brain tissues. (TCO)

**31895** THE EFFECT OF RADIOACTIVE DECAY ON THE GENOME OF THE BACTERIOPHAGE T4. Harriman, Philip Darling. Thesis, Berkeley, Calif., Univ. of California, 1964. 136p.

The functional inactivation of particular phage genes by $^{32}$P decay was determined by measuring the survival of the ability of a $^{32}$P-labeled wild type phage to help (complement) the growth of a phage carrying a mutation which rendered it functionally defective for the particular gene which was to be studied. Using this technique, it was found that the functioning of a particular gene is inactivated at about half the rate of inactivation of phage viability. By following the inactivation of complementation of phage carrying more than one mutation, it was determined that approximately half of all lethal $^{32}$P hits inactivate the functioning of all phage genes (long-range hits), and that the other half of the lethal hits inactivate only a few genes, of the order of one-tenth of all phage genes (short-range hits). The two types of lethal hits are physically distinct in that the free radical trap AET preferentially reduces the incidence of short-range hits. The sensitivity of a particular gene to short-range hits was found to be identical to its sensitivity to ultraviolet light induced lethal hits. The genetic survival of phage genes after $^{32}$P decay through cross-reactivation, or gene rescue, was also followed. It was found that gene rescue is inactivated at the same rate as gene function; assay for the simultaneous inactivation of gene rescue and gene function showed that they are inactivated by identical

lethal hits. The time after infection at which a particular phage gene functions was inferred from the time at which function of the gene could no longer be inactivated by $^{32}P$ decay. It was found that early and late genes become insensitive to decay inactivation at about the same time, indicating the possibility that both types of genes begin to function at about the same time. However, a difference between the time of functioning of early and late genes appears if protein synthesis is inhibited by removing amino acids from the growth medium after phage infection. After amino acid removal, the early genes become insensitive to decay inactivation at the same time as they would have without such removal (about ten minutes after infection), whereas under these conditions, late genes are still sensitive to decay inactivation after thirty-two minutes of phage development. If the antibiotic chloramphenicol is used to inhibit protein synthesis, the functioning of neither early nor late cistrons becomes insensitive to decay inactivation, indicating that gene function does not commence in the presence of the antibiotic. (TCO)

**31896** THE REPLICATION OF DNA IN ESCHERICHIA COLI FOLLOWING IRRADIATION WITH ULTRAVIOLET LIGHT. Parker, Evelyn Dorothy. Thesis, Berkeley, Calif., Univ. of California, 1964. 182p.

An investigation was made of DNA synthesis in ultraviolet-irradiated cultures of E. coli, using principally density gradient techniques. Nitrogen-15-labeled cultures of E. coli B/r thy⁻ were irradiated with ultraviolet light and incubated thereafter in $^{14}N$ medium. At intervals during post-irradiation incubation the distribution of $^{15}N$ in the DNA of the cultures was determined by analytical density gradient centrifugation of samples from the cultures. At similar times aliquots of the cultures were exposed briefly to $^{3}H$-thymidine to label the active growing points in the DNA, and the $^{15}N$ content of this $^{3}H$-labeled DNA determined by density gradient centrifugation and counting of the radioactivity in serial samples from the density gradient. The rate of DNA synthesis in the irradiated cultures was also followed during the incubation by measuring the incorporation of $^{3}H$-thymidine in short periods of time by small aliquots of the cultures. The behavior of cultures incubated with 300 $\gamma$/ml chloramphenicol (to specifically inhibit protein synthesis) after irradiation was compared with that of cultures in which protein synthesis was permitted to occur after irradiation. DNA synthesis was found to be sharply inhibited by ultraviolet irradiation, but to recover during postirradiation incubation to an extent and at a rate that depended on the dose of ultraviolet light administered. In the absence of protein synthesis this recovery did not occur, but the low rate of DNA synthesis prevailing immediately after irradiation continued for several hours in the absence of protein synthesis. DNA replication in the irradiated cultures was found to be semiconservative, as in unirradiated cultures of E. coli. (Dissertation Abstracts)

**31897** THE EFFECT OF RADIATION ON PHASES OF THE LIFE CYCLE OF L-STRAIN (WAYMOUTH 705) MONOLAYER CULTURES. Quinn, Mary Genevieve. Thesis, Washington, D. C., Catholic Univ. of America, 1964. 43p.

Autoradiography, utilizing tritiated thymidine, was employed to study the effect of radiation on the life cycle of monolayer cultures of Strain-L mouse fibroblast cells. A $^{60}Co$ radiation source was used to deliver doses of 500 R and 1500 R. Samples were taken at 24 and 72 hrs after radiation. The total generation time of untreated cultures was 28 hours. The total generation time and the phases of the life cycle are lengthened as a result of radiation. Twenty-four hours after radiation the total generation time of the culture treated with 500 R had doubled while the 1500 R cultures almost quadrupled. At seventy-two hours post-radiation the values were nearing the control value. The generation time of 500 R radiated cultures was very slightly higher than that of the controls while the cultures exposed to 1500 R had a generation time double that of the control value. The increase in the phase times over the control at 24 hours was distributed proportionally throughout the cycle. No one phase was more affected than another. As the generation time decreased toward normal values at 72 hours there was no distortion of any phase. (TCO)

## Radiation Effects Therapy and Countermeasures

**31898** (HW-SA-3679) ORAL THERAPY FOR DEPOSITED PLUTONIUM. Ballou, J. E.; Palotay, J. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). [Aug. 14, 1964]. Contract AT(45-1)-1350. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI

Effective oral therapy for plutonium in rats was obtained with a triethylenetetraminehexaacetic acid (TTHA) dose of 3 mM/kg administered one hour after plutonium citrate injection. Daily oral administration of a 1.5 mM/kg dose, initiated one hour after plutonium injection and continued for nine days, was only marginally effective. Measurement of the enhanced excretion of plutonium in the bile during perfusion of different intestinal segments with chelating agents indicated that the agents are absorbed primarily in the jejunum and ileum. Means of promoting absorption and limitations on oral therapy are discussed. (auth)

**31899** (NP-15072) QUARTERLY PROGRESS REPORT NO. 55 [ON RADIOBIOLOGY], APRIL 15, 1965. (Chicago Univ., Ill. Air Force Radiation Lab.). Contract AF41(609)-1693). 104p.

Separate abstracts were prepared for seven sections of this report. (C.H.)

*For abstracts of individual sections see: 31702, 31785, 31786, 31900, 31901, 31902, and 31903.*

**31900** (NP-15072(p.37-70)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. I. DOSE-MORTALITY RELATIONSHIPS FOR SEVERAL RADIOPROTECTIVE AGENTS. Plzak, V.; Doull, J. (Chicago Univ., Ill. Air Force Radiation Lab.).

Dose reduction factors (DRF) for eight radioprotective agents and six salts of aminoethylisothiourea were determined in $CF_1$ male mice using a computer programmed maximum likelihood estimate procedure based on the 30-day mortality data following whole-body x ray exposures in the range of 400 R through 900 R. 2-Quinolinol (EK-1812) was the most effective (DRF = 1.3) of the non-AET salts included in the present series of compounds. DRF values of about 1.2 were obtained with 8-quinolinol (EK-794), N-(p-methoxyphenyl)-monothiosuccinimide (WI-4), WL-13, and GE-27. Quinoxaline (EK-7094 and PD-120) exhibited little protective activity (DRF of less than 1.1) and the DRF for PD-28 was less than 1. The perchlorate salt of AET exhibited a DRF of 1.7 whereas the sulfate salt had a DRF of 1.5. Both the dinitrate and dichloride salts of AET exhibited DRF values of about 1.4 and the sample of AET dibromide included in these studies was relatively inactive (DRF of 1.1). A listing of the DRF values for fifty of the most effective radioprotective agents tested in the radiation screening program of this laboratory was prepared using the averaged mortality data obtained from the control (non-treated) groups of a series of DRF studies carried out in this laboratory. (auth)

**31901** (NP-15072(p.71-81)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. II. MICROSCOPIC FINDINGS IN THE SPLEENS OF MICE GIVEN DIMETHYL SULFOXIDE OR OTHER CHEMICAL RADIOPROTECTIVE AGENTS PRIOR TO LETHAL WHOLE-BODY X-RAY EXPOSURE. Vesselinovitch, D.; Simmons, E. L.; Fitch, F.; Doull, J. (Chicago Univ., Ill. Air Force Radiation Lab.).

The effect of dimethylsulfoxide (DMSO) on the gross and

microscopic changes produced in the spleen of female $CF_1$ mice by whole-body x ray exposure (800 R) were compared with those produced by aminoethylisothiouronium (AET) and p-aminopropiophenone (PAPP). Although DMSO exhibited radioprotective activity in the hematopoietic system in terms of recovery of the spleen weight and colony formation, these effects were less marked than those produced by the administration of either AET or PAPP. Regeneration of the hematopoietic elements in the radiation damaged spleen was qualitatively similar following the administration of DMSO, AET, and PAPP except for a more pronounced recovery of the myelopoietic series in the PAPP-treated mice. (auth)

**31902** (NP-15072(p.82-7)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. III. RELATIONSHIP BETWEEN SPLEEN OXYGEN TENSION AND RADIOPROTECTION WITH P-AMINOPROPIOPHENONE (PAPP) IN MICE. Hasegawa, A. T.; Landahl, H. D. (Chicago Univ., Ill. Air Force Radiation Lab.).

The relative oxygen tension in the spleen of mice were 0.74, 0.35, and 0.49 of normal at 4, 15, and 60 minutes after PAPP injection. In propylene glycol treated mice, the oxygen tension values were 0.96, 1.02, and 1.78 at the corresponding times. The $LD_{50}$ value for the control mice was 580 R. In PAPP-treated mice the $LD_{50}$ values at 4, 15, and 60 minutes were estimated to be 745 R, >1,000 R, and 840 R respectively. The $LD_{50}$ values when PAPP was injected in anesthetized mice were estimated to be 1,000 R, 980 R, and 870 R at 4, 15, and 60 minutes. (auth)

**31903** (NP-15072(p.88-102)) THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. I. HYPERBARIC OXYGEN EXPOSURE AND RADIATION MORTALITY IN ANIMALS. Doull, J.; Simmons, E. L.; Marks, E. L.; Plzak, V. J. (Chicago Univ., Ill. Air Force Radiation Lab.).

The ability of mice, rats, and rabbits to withstand chronic hyperbaric oxygen exposure was investigated using various cycling schedules of alternate oxygen and air exposure. The chronic exposure of male and female $CF_1$ or $C_{57}$/BL mice to hyperbaric oxygen in a cycle consisting of 1 hour of oxygen at 15 psig followed by 15 minutes of air at 0 psig (repeated nineteen times daily) produced a mortality of between 80%, and 100% during a 30-day exposure period. The $CF_1$ mice appeared to tolerate the oxygen exposure slightly better than the $C_{57}$/BL mice and male $CF_1$ mice were more resistant to the oxygen exposure than female $CF_1$ mice. Reducing the oxygen pressure to 10 psig permitted male and female $CF_1$ mice, Sprague Dawley rats, and a rabbit to survive an exposure period of 30 days. New-born and weanling $CF_1$ mice appeared to be less susceptible to the effects of chronic hyperbaric oxygen exposure than adult animals of the same strain. The exposure of male $CF_1$ mice to hyperbaric oxygen (1 hour $O_2$ at 15 psig plus 15 minutes in air at O psig repeated nineteen times each day) for 4 days prior to whole-body x ray exposure increased slightly the median survival time and the number of animals surviving at 30 days after the radiation exposure. Post-irradiation exposure to a similar chronic hyperbaric oxygen situation increased radiation mortality in groups of mice exposed to 450 R and decreased slightly the lethal effects of 650 R of whole-body x irradiation. The greatest radioprotective effect of hyperbaric oxygen exposure was observed when the animals were exposed to the increased oxygen concentration for 4 days and then permitted to recover for 3 days prior to irradiation. Hyperoxia in the range of 20% through 84% oxygen during whole-body x ray exposure did not markedly alter the lethal effect of x ray doses of 400 R, 500 R, or 600 R. Subjecting mice to increased air pressure (15, 30, or 45 psig) during whole-body x ray exposure also failed to markedly influence the mortality response of similar x ray doses. (auth)

**31904** (NYO-2628-1) REDUCTION OF POST-IRRADIATION INFECTIONS BY REPLACEMENT OF THE NORMAL ENTERIC FLORA AND BY SPECIFIC IMMUNIZATION. Final Report, August 1, 1960–September 30, 1964. Freter, Rolf (Jefferson Medical Coll., Philadelphia, Pa.). Contract AT(30-1)-2628. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Ways to reduce post-irradiation infections were investigated in mice. It was shown very definitely that certain bacteria (such as Pseudomonas) may be eliminated from the intestinal tract by means of the antagonism exerted by certain strains of E. coli which could be established in the intestinal tract of the irradiated animal. Removal of certain species was complete to the point where these bacteria did not cause post-irradiation infection. A continuation of this study concerning the effect of intestinal anaerobes and the antagonism they exert upon other intestinal bacteria indicated that, with the proper combination of antagonistic strains, all invaders of the intestinal tract could be eliminated before they become a problem in post-irradiation infections. While establishment of a strongly antagonistic intestinal flora may eliminate those bacteria which are highly virulent for the irradiated mammalian host (such as Pseudomonas), there is the definite possibility that the antagonistic flora itself may eventually invade the host. This could, of course, be minimized by establishing antagonistic strains of very low invasiveness. In addition to this, immunologic protection of the host was considered. While there was no apparent gain in resistance to systemic challenge infections of lethally irradiated animals after active or passive immunization, there was a significant degree of protection against oral challenge infections after active immunization. The effect of bone marrow transplants and of homologous disease on the susceptibility to infections was also studied. The results showed a surprisingly quick (within 6 days) recovery of resistance to infection, which is only slightly lowered during the presence of homologous disease. (C.H.)

**31905** (ORNL-3768(p.99-108)) MAMMALIAN RECOVERY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: factors affecting mortality from secondary disease; oxygen consumption in radiation chimeras; changes in the partition of total-body nitrogen in irradiation chimeras; electron microscope observations on splenic white pulp during the early intervals of a primary immune response; the effect of incubation temperature on survival of irradiated mouse bone marrow cells; the persistence of P1 spleen cells injected into adult P2 mice made tolerant at birth by injection of (P1 × P2)F1 cells; a new in vivo technique for mammalian cells; and bacteriological investigations in mice inoculated with a pigmented and a nonpigmented Pseudomonas. (H.G.D.)

**31906** (ORNL-3768(p.179-80)) CHEMICAL PROTECTION AND ENZYME CATALYSIS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: chemical protection; chromatography of mouse kidney muramidase; and muramidase activity in lymphatic macrophages of mice. (H.G.D.)

**31907** (TID-21799) TISSUE THERAPY AFTER IRRADIATION. Koller, P. C. (Chester Beatty Research Inst., London (England)). [1964]. Contract AT(30-1)-2702 and IAEA Contract 103/3/US. 14p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Progress is reported in studies of the effects of radiation dose and the injection of various types and numbers of hematopoietic cells on recovery of mice from doses of 300, 500, and 700 R x radiation; a comparison of methods of preserving hematopoietic cells; the effects of removal of the thymus on immune reactions in irradiated mice; the effects of irradiation on pre-existing immunity in mice; the effectiveness of thymus grafts in restoring immunological competence to neonatally thymectomized mice; and the effects of thymus grafts on the life span of irradiated mice injected with foreign bone marrow. A list is included of 18 publications during the period covered by this report. (C.H.)

**31908** THE PROTECTIVE EFFECT OF MERCAPTAMINE IN DISTURBANCES OF THE Na AND FLUID METABOLISM IN THE GASTROINTESTINAL RADIATION SYNDROME. Zseboek, Z.; Petranyi, G. Jr. Acta Med. Acad. Sci. Hung., 20: 215-22(1964).

A study was made of the protective effect of mercaptamine against intestinal radiation death and the mechanism of this process. Rats were given a whole-body radiation dose of 1500 R and determinations were made of, the total exchangeable Na, and its distribution in the organism, intestinal Na absorption, and the extracellular space and the Na content of the intestinal juice. The conclusion was drawn that mercaptamine has a partial and indirect protective effect only on the lethal changes in Na and water balance during the gastrointestinal syndrome. This dose of radiation mercaptamine does not reduce the damage to the intestinal absorption or the intestinal sodium loss. The indirect protective effect consists of mobilization of the sodium reserve of the organism (the stable sodium content of the bones) and an increase in the extracellular Na. Thus the extracellular sodium loss does not attain a lethal value. Finally, mercaptamine reduced the loss of water. Changes in Na and water balance occurring in intestinal radiation death are discussed in detail. (Excerpta Med., XXIII, 2: No. 4, (Apr. 1965))

**31909** OCCUPATIONAL RADIODERMATITIS OF THE FINGERS: TREATMENT TECHNIQUE. Lagrot, F. (Centre Hospitalier and Universitaire, Toulouse). Ann. Chir. Semaine Hop., 18: 1511-18(Dec. 1964). (In French)

Two techniques for graft excision of radiodermatitis are described. They were performed on 60 patients occupationally exposed to radiations. In the sewn vaseline mold technique a local or general anesthetic is used, depending on the number of fingers operated on. The hand is slipped into a jersey stocking, covering all but the finger to be operated on and is handled as little as possible. The lesions are examined and the limits of excision drawn on the skin. The excision generally removes the dorsal integument of the last two phalanges, the nail with its matrix and stratum, and the pulpy skin of the third phalange. A 0.5% Novocaine solution is injected. The cutaneous layer is removed, leaving a vesicular cover which serves as a base for the graft. The dissection of the nail is the most delicate part of the operation. When hemostatis is completed, the mold is formed on the finger. The threads are placed and the finger covered with wet gauze. Skin for the graft is removed from the thigh or forearm and cut to fit the mold of the finger. When the graft is sewn in place, the wound is dressed. The second technique, graft by simple apposition, is a modification of the first. No mold is made, and the graft is applied to the finger and fixed with a few catgut stitches. Sterile jersey, on a metal tube, is slipped over the finger to form a three-layer cover. This technique shortens the time necessary for the operation and the accompanying problem of anesthesia. The dressing can be removed in two or three days, and the patient should exercise the finger to prevent stiffening. The percentage of grafts that survive is much higher with the second technique. (BBB)

**31910** RADIOPROTECTIVE ACTION OF CYSTEAMINE AND CYSTAMINE IN THE MOUSE AS A FUNCTION OF THE TIME SEPARATING THE INJECTION OF THE PROTECTOR FROM THE BEGINNING OF IRRADIATION BY X RAYS. Bacq, Z. M.; Beaumariage, M. L. (Universite, Liege). Arch. Intern. Pharmacodyn., 153: 457-9(Feb. 1965). (In French)

Black $C_{57}$ mice of both sexes were injected with 150 mg of cysteamine or cystamine. After ten, 25, 45, or 60 min they were subjected to total x irradiation of 900 R, at the rate of 238 R/min. Control mice were injected with saline solution and irradiated at the same time as the other mice. All the controls died between the fourth and fifth day after irradiation. Of the cysteamine group, those injected ten min before irradiation had 40% survival after 30 days and an average survival time of 17.2 days. Those injected 25 min before had 22.5% survival after 30 days and an average of 12.1 days. Those injected 45 min before had 2.5% survival after 30 days and an average survival of 9.2 days. None of the mice injected 60 min before irradiation survived 30 days and the average survival was only 6.7 days. In the cystamine group, mice injected ten min before irradiation had 25% survival and an average survival of 14 days. Those injected 25 min before had 5% survival after 30 days and an average survival of 7.5 days. The mice injected 45 or 60 min before had only 2.5% survival after 30 days and an average survival of 7.0 and 6.8 days, respectively. Radioprotection is best if the substances are injected ten min before irradiation. Cysteamine is more effective than cystamine as a radioprotector. (BBB)

**31911** IMPORTANCE OF THE GENES FOR TISSUE COMPATIBILITY IN THE SURVIVAL OF MICE SUBJECTED TO WHOLE-BODY GAMMA IRRADIATION AND PROTECTED WITH BONE MARROW GRAFTS. Margado, T. F. Biologica (Santiago), 35: 76-114(1963).

Strains of coisogenic mice were employed for determining the effect of gene differences on secondary mortality in animals submitted to total gamma irradiation of their bodies, and protected by means of bone marrow grafts. High secondary mortality rates were observed when donor and host differed in locus H-2, whereas differences in loci H-1 and/or H-3 yielded low mortality rates. Immunization of the host against tissues of the donor, before irradiation accelerated death in comparison to nonimmunized hosts in all cases where differences existed in locus H-2. When the situation was reversed, the effect was observed only in cases with a difference in loci H-1 and/or H-3. An unexpected result was that bone marrow from hybrid donors produced a high mortality rate. (TCO)

**31912** SOME PROPERTIES OF RLP—A FACTOR FROM SHEEP SPLEEN CAPABLE OF INHIBITING RADIATION LEUKEMOGENESIS IN MICE. Berenblum, I.; Cividalli, G.; Trainin, N.; Hodes, M. E. (Weizmann Inst. of Science, Rehovoth, Israel). Blood, 26: 8-19(July 1965).

A cell-free factor, radiation-leukemia-protection (RLP), derived from sheep spleen was shown to be heat-labile, nondialyzable, not present in significant amounts in the RNA fraction of the crude material, not inactivated by DNAase, and recoverable in active form after precipitation with 30 per cent ammonium sulfate. From the evidence so far available, it thus appears that RLP is a protein of high molecular weight. Only borderline inhibition was obtained with extract of sheep kidney, and no inhibition with lactalbumin hydrolysate, thus supporting the view that the inhibitory effect of sheep spleen extracts is probably the result of a specific action and not brought about by a nonspecific, stress-mediated mechanism. (auth)

**31913** SELECTIVE PROTECTION OF THE GASTROINTESTINAL TRACT AGAINST RADIATION INJURY BY PERFUSION WITH MEG (2-MERCAPTOETHYLGUANIDINE HYDROBROMIDE). Ambrus, J. L.; Ambrus, C. M.; Pickren, J. W.; Feltz, E.; Back, N. (Roswell Park Memorial Inst. and State Univ. of New York, Buffalo). Cancer Res., 25: 609-23(June 1965).

A procedure was developed for perfusing the gastrointestinal tract of rats with solutions of MEG, the active metabolite of 2-aminoethylisothiouronium (AET), during whole-body irradiation. In Fischer 344 rats, whole-body irradiation with 900 R was found to kill all animals by producing intestinal injury within one week, before hemopoietic depression could fully develop. Transplantation of isologous bone marrow did not protect against such doses of radiation. Whole-body irradiation with 900 R was survived by 19 of 20 animals when the gastrointestinal tract was perfused with MEG during irradiation and isologous bone marrow transplantation was performed after irradiation. This procedure showed some protection against whole-body irradiation with 1200 R and possibly 1500 R, but all animals succumbed after 1800 R. Single whole-body irradiation with 900 R combined with intestinal protection and bone marrow transplantation failed to eradicate dis-

seminated transplanted Dunning leukemia IRC 741. To determine the radiation sensitivity of Dunning leukemia cells, subcutaneous implants were irradiated 24 hrs after implantation, the rest of the animal being protected with lead shielding. It appears that doses in excess of 5000 R are required in order to eradicate this tumor. If the Dunning IRC 741 leukemia can be considered representative of diseases of the lymphoma-leukemia group, it is not likely that the procedure outlined will allow selective radiation therapy of disseminated hematologic malignancy with whole-body irradiation, because of the high radiation doses needed. It is conceivable, however, that filling intestinal loops in the irradiation field with MEG solutions may permit delivery of higher doses of local radiation to radiation-responsive abdominal tumors than are allowable at the present time. (auth)

**31914** THE RADIORESTORATION ACTION OF A GROWTH FACTOR EXTRACTED FROM THE RIBONUCLEIC ACID OF YEAST. Jonard, Robert; Kovoor, Aries (Universite de Paris). Compt. Rend., 260: 4592-4(Apr. 26, 1965). (In French)

A growth factor isolated from the ribonucleic acid of yeast is capable of restoring the proliferation of crown-gall tissues of Scorsonere exposed to the effects of x radiation. (tr-auth)

**31915** RESULTS OF TRANSPLANTATION OF AUTOLOGOUS BONE MARROW IN IRRADIATED RHESUS MONKEYS. Magliulo, E.; Van Putten, L. M.; De Vries, M. J. Haematologica (Paris), 49: 213-36(1964).

The results of autologous bone marrow transplantation in lethally irradiated Rhesus monkeys (Macaca mulatta) are reported. Autologous bone marrow transplantation, provided a satisfactory number of cells was injected, allowed irradiated monkeys to survive and to regenerate their hematopoietic system. Clinical, hematological, and pathological findings are discussed in relation to factors such as cell number injected and x-ray dose. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31916** FURTHER STUDIES ON THE RADIOSENSITIZING ACTION OF SODIUM CYCLOHEXYL SUCCINATE. Scolari, E. G.; Boiti, D.; Vallecchi, C.; Nannelli, M. (Universita, Florence). Hautarzt, 15: 285-7(1964).

A report is given on a clinical trial of sodium cyclohexyl succinate. The concentration of this substance is probably higher in neoplastic cells than in normal cells and it causes an inhibition of anaerobic glycolysis in the tumor cell. As glycolysis is an important source of energy for the tumor cell and a very secondary source for normal cells the drug causes damage to tumor cells (reduced concentration of DPN, ATP, etc.). Tumor cells damaged in this way are more sensitive to radiation than undamaged tumor cells. The results showed that in tumors with low malignancy the radiation dose can be reduced while results remain unaffected. In tumors with a more malignant nature the same dose of radiation led to an increase in the number of recoveries. Tumors with a very high resistance to radiation showed improved response. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31917** THE TREATMENT OF X-IRRADIATED GERM-FREE CFW AND $C^3H$ MICE WITH ISOLOGOUS AND HOMOLOGOUS BONE MARROW. Connell, Mary St. James; Wilson, Raphael (Univ. of Notre Dame, Ind.). Life Sci., 4: 721-9(Mar. 1965).

To distinguish pathologic changes attributable directly to whole-body irradiation from those due to postirradiation bacterial infection and other consequences of microbial association, germfree CFW mice were used. These animals have a higher resistance to x irradiation and live longer following lethal doses. The dose-response curve is shifted about 50 R upward, resulting in 30 to 50% increases in survival at specific levels in the midlethal range. Hematologic damage is not as great in the germfree mouse as in the conventional at sublethal doses, but at higher doses, with the exception of neutrophils, there is no detectable difference in the degree of depression of circulating blood cells. However, both red cell counts and platelet counts decrease more slowly in germfree than in conventional mice. The effect of microörganisms associated with the experimental animal on the ability of bone marrow transplants to prevent death within a 30-day observation period in irradiated CFW and conventional mice was studied. They were exposed to single doses of whole-body x irradiation, conventional mice receiving doses from 750 to 1150 R, germfree mice 800 to 1600 R. Within 24 hr postirradiation the mice were injected with pooled isologous marrow cells. The $LD_{50}$ of conventional C3H mice which received isologous marrow was 860 R; for those which received homologous (CFW) marrow, it was 750 R. Isologous marrow treatment of germfree C3H mice resulted in an $LD_{50(30)}$ of 1350 R; homologous treatment in one of 1325 R, an increase of 500 to 600 R over that of their conventional counterparts. The conventional CFW mice treated with homologous marrow had an $LD_{50}$ of 850 R, for the mice given isologous cells, the $LD_{50}$ is 900 R. The germfree CFW mice which received isologous marrow cells had an $LD_{50}$ of 1650 R, while those which received homologous (C3H) marrow had one of 1250. The difference here between germfree and conventional mice was 400 R for homologous transplants and 800 R for the isologous ones. In all these groups the mean survival times of animals that died during the 30-day observation period did not differ significantly from those of uninjected controls. In attempts to explain the great difference between conventional and germfree mice given the same treatment, the possibility was considered that there is a greater number of proliferative cells in the marrow of germfree donors. To test this, the spleen colony count method was applied. Germfree mice were irradiated and given 30,000 isologous cells from germfree donors, and irradiated conventional animals received the same number of cells from either conventional or germfree donors. The number of colonies did not differ significantly in these three groups. Conventional mice receiving 800 R and germfree mice receiving 1000 R showed comparable survival percentage, length of life, and peripheral blood counts. To test further the ability of the stem cells to repopulate the marrow and spleen, irradiated mice were given bone marrow as described above and sacrificed at 2-day intervals. Various parameters showed little difference between germfree and conventional mice until about 12 days postirradiation, when conventional spleens were significantly larger than germfree spleens. However, this did not indicate a lack of stem cells in the germfree animal, because the total white cell counts were comparable in the two groups. (BBB)

**31918** THYMUS CELLS OF RADIATION-CHIMERAS: TL PHENOTYPE, SENSITIVITY TO GUINEA-PIG SERUM, AND ORIGIN FROM DONOR CELLS. Schlesinger, Michel; Boyse, Edward A.; Old, Lloyd J. (Sloan-Kettering Inst. for Cancer Research, New York; Cornell Univ., New York; New York Univ., New York). Nature, 206: 1119-21(June 12, 1965).

The thymus cells of radiation-chimeras formed by the intravenous inoculation of bone marrow or spleen cells into lethally irradiated mice, using donors and recipients of different TL types, were examined. The mice were irradiated using two opposing x-ray fields to a total dose of 850r. Three hours after irradiation they received an intravenous injection of either bone marrow cells or spleen cells. At various intervals the mice were killed and their thymus, spleen, and bone marrow cells examined. Tests indicated virtually complete repopulation by donor cells within 24 days. The donor cells that repopulated the thymus showed the sensitivity to unabsorbed guinea-pig serum (GPS) characteristic of thymus cells. On the other hand, the spleen and bone marrow cells of these radiation-chimeras, like the spleen and bone-marrow cells of normal mice, were resistant to the cytotoxic effect of GPS. Data are presented in tables. (M.C.G.)

**31919** CHROMOSOMAL ABERRATIONS IN SYNCHRONIZED MAMMALIAN CELLS TREATED WITH 5-BROMO-

DEOXYURIDINE AND IRRADIATED BY ULTRA-VIOLET LIGHT. Djordjevic, Bozidar (Biological Inst., Belgrade); Djordjevic, Olga. Nature, 206: 1165-6(June 12, 1965).

The combined effects of 5-bromodeoxyuridine and ultraviolet radiation on the chromosomal structure of D98S cells were investigated. Without drug pre-treatment, no aberrant chromosomes were found in any of the cells. In pre-treated cells, those irradiated 3 hr after mitosis did not show aberrant chromosomes, but among the cells irradiated 20 hr after mitosis, 14% of the metaphase figures were found to contain chromatid breaks or translocations. In contrast, among 50 metaphase figures from non-irradiated cells treated with drugs for 20 hr, only one was detected with a chromatid break. After 20 additional hours of incubation with 5-bromodeoxyuridine, 100% of the irradiated cells yielded metaphase figures with aberrant chromosomes. Even without irradiation 25% had abnormal chromosomes. Maximum chromosomal damage was achieved in cells which were passed through the DNA replication cycle twice in the presence of 5-bromodeoxyuridine. (M.C.G.)

**31920** THE TRANSPLANTATION OF ALLOGENOUS BONE-MARROW IN DOGS IRRADIATED SUPRALETHALLY. Certkov, I. L.; Novikova, M. N.; Rogaceva, L. S.; Maksimenko, A. S.; Sepselevic, L. L.; Samojlina, N. L.; Kozinee, G. I.; Rausenbach, M. O. (Lenin-Institut fur Hamatologie and Bluttransfusion, Moscow). Radiobiol. Radiotherap., 6: 129-61(1965). (In German)

Examinations of 30 dogs irradiated supralethally showed that a transplantation of allogenous bone marrow one day after irradiation is accompanied by a transformation of the blood-forming cells passing a number of hyperbasophilic transitional forms into lymphocytes. The effect does not depend on the presence of lymphocytes in the transplant. In a delay of transplantation by 4 to 5 days after irradiation there was no transformation in some of the dogs and the blood was formed normally. Five weeks after irradiation the formation of blood began to resume in the surviving dogs and the partial chimaerism came to an end. (tr-auth)

**31921** INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION. PART 62. THE INFLUENCE OF 5-HYDROXYTRYPTAMINE (SEROTONIN) ON THE MITOTIC ACTIVITY AND THE CHROMOSOMES IN BONE MARROW AFTER SUBLETHAL WHOLE-BODY IRRADIATION OF MICE. Langendorff, Hanns; Shibata, Kyoko (Universitat, Freiburg i. B. and Heiligenberg-Institut, Heiligenberg/Baden, Ger.). Strahlentherapie, 127: 133-45(May 1965). (In German)

The effect of prophylactic administration of 5-hydroxytryptamine (Serotonin) upon the mitosis rate and chromosomal substance of bone marrow was investigated in mice which were total body irradiated with 810 R. Administration of serotonin alone causes a short time inhibition of the mitosis activity; it also induces minor disturbances in chromosomes. Total body irradiation with 810 R causes a complete inhibition of the division ability in bone marrow of mice for a protracted time. Also the mitotic rate during irradiation was severely depressed. The radiation induced decrease in the mitosis index with the following mitosis free interval as well as the great disturbance in mitoses occurring shortly after radiation exposure cannot be avoided by administration of serotonin prior to irradiation. Nevertheless, serotonin causes a rapid recovery of the mitosis activity and an increase in the mitotic rate above normal values in bone marrow of irradiated animals. The number of the chromosomal damages observed is at first small, but increases with increased time intervals after irradiation. Probable causes are discussed. (tr-auth)

**31922** INVESTIGATIONS ON THE EFFECTIVENESS OF URIDINE MONOPHOSPHATE AND CYTIDINE MONOPHOSPHATE ON RADIATION INJURIES. Fukuda, Masashi; Abe, Mitsuyuki; Tanaka, Yoshimasa; Hashi, Masatomo (Kyoto Univ.). Strahlentherapie, 127: 146-51(May 1965). (In German)

Not only prophylactic but also therapeutic effects upon irradiated mice are observed by the administration of uridine monophosphate (UMP). However cytidine monophosphate (CMP) has no positive influence. The $^{59}Fe$ uptake of rats to which UMP was given before irradiation is higher than of irradiated control rats. On the contrary the $^{59}Fe$ uptake of rats to which CMP was given before irradiation is rather lower than controls. No great difference of the mitotic activity is observed between the fibroblasts which were treated with UMP or CMP and not treated fibroblasts. Possible mechanisms of the prophylactic and therapeutic effect of UMP are discussed. (tr-auth)

**31923** ON THE COMBINED USE OF A CHEMICALLY PROTECTIVE MIXTURE OF CYSTEAMINE AND AMIDINE WITH BONE MARROW TRANSPLANTS IN ACUTE RADIATION SICKNESS. Zographov, Dimiter G.; Robev, Stefan K.; Baev, Ilia A.; Bonev, Luebomir E. (Forchungsinstitut fur Radiologie und Strahlenhygiene, Sofia). Strahlentherapie, 127: 152-9(May 1965). (In German)

The effectiveness of the combined administration of a chemical mixture (cysteamine + N[4-Nitrophenyl]-benzamidine) prior to total body irradiation followed by bone marrow transplantation was investigated in male Wistar rats. Survival rate, changes in blood count, myelogram data, and the 24-hour incorporation rate of $^{59}Fe$ into erythrocytes were used as criteria. Using a radiation dose which was supralethal for the control group, the survival rates were 72% in chemically protected rats, 54% in animals treated with bone marrow, and 98% in animals which received combined treatment with the chemical protective substance and the bone marrow transplantation. The latter group showed the fastest regeneration in hematopoesis. It is assumed that the synergism of both methods influences the bone marrow mechanism in the acute radiation death. (tr-auth)

**31924** TECHNIQUE FOR STUDIES ON RADIOPROTECTIVE EFFECTS ON HUMAN CELLS CULTURED IN VITRO (HeLa CELLS). Cheymol, J.; Daysson, G.; Adolphe, M.; Heitz, F. (Institut de Pharmacology, Paris). Therapie, 19: 1059-70(1964).

At present much research in radiobiology is done using in vitro cell cultures. Chemical protection against radiation was studied by experiments on irradiated animals. In parallel with this a method was developed for studying radioprotective substances using HeLa cells. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

## Radiation Hazards and Protection

*See also* HEALTH AND SAFETY.

**31925** RADIATION PROTECTION. Shaw, Wallace M. (Mid-Island Hospital, Bethpage, N. Y.). Anesthesiology, 22: 1019(Nov.-Dec. 1961).

Because of the possible radiation exposure of anesthesiologists, a simple shield for use during cystoscopic procedures was devised. Exposures during such operations are from primary x rays from the tube and scattered secondary rays when the primary rays strike the patient and the table. Both these rays may reach the anesthesiologist, particularly if he remains seated. Most persons can leave the operating room during roentgenographic studies but the anesthesiologist often must remain with the patient to maintain an airway or control respiration. In the belief that radiation exposure should be avoided whenever possible, the shield, which is illustrated, was devised and has been in use for five years. A curtain of leaded rubber equivalent to ¼ in. of lead shielding is suspended from the overhead roentgenographic tube mounting by a bracket. Leaded rubber can be purchased as such or the lower part of a discarded protective leaded rubber apron can be used. It is hung to fall about the shoulders of the patient, with a notch cut in it for the neck. When the tube is swung aside, the curtain is carried with it or the curtain can be lifted and draped over the mounting bracket. A similar curtain is

hung from the bottom of the cystoscopy table about 14 in. from the head end so as to just touch the floor. Construction details are shown, although dimensions may vary with the size of the table. It is important to provide secure attachments for the upper edge of the curtains because they are heavy. (BBB)

**31926** RADIATION PROTECTION IN INDUSTRIAL INVESTIGATIONS WITH TRACERS. DETERMINATION OF THE MAXIMUM APPLICABLE AMOUNTS OF ISOTOPES. Bujdoso, E. Kohasz. Lapok, 97: 204-7(Apr. 1964). (In Hungarian)

According to the operative standard MSZ 62-61 in industrial investigations with tracers the amount of indicator can be determined for containers connected in series and for pipe lines. The corrections for the different types of flow and the methods of their determination are described. (OID)

**31927** COPPER, HYDROGEN PEROXIDE, AND CANCER. Williams, J. Richard Jr.; Steele, Richard H. New Engl. J. Med., 271: 742(Oct. 1, 1964).

Studies on the action of the free hydroxyl radical, •OH, generated during the photoinduced chemiluminescence of riboflavin in hydrogen peroxide revealed a marked enhancement of the observed emission by copper ion. This observation, coupled with a realization that the action of •OH radicals in neoplastic cells subjected to radiotherapy involves the conversion of sulfhydryl groups to disulfide bridges, stimulated interest in the relation between Cu, HOOH, and carcinoma cell metabolism. A proposed mechanism of radiation protection attributes this feature to agents that complex Cu. Radiation damage caused by the •OH and •OOH radicals is increased in the presence of Cu ion and prevented if these radicals and Cu are prohibited from interacting. On the basis of this circumstantial evidence it is suggested that the roles played by Cu and the •OH radical species deserve more extensive investigation. Assuming that the problem of increasing the radiosensitivity of carcinomatous growths presents itself as a problem of increasing the local concentration of the free radical, •OH, any method whereby the local intracellular concentrations of Cu and HOOH are increased might be effective to this end. Thus, solutions of copper sulfate and hydrogen peroxide have been used to hydroxylate aromatic rings via a free radical mechanism involving •OH. The ambivalent action of the free hydroxyl radical is emphasized; consequently, its cytopathogenic action should be used with recognition of its carcinogenic potential. (BBB)

**31928** CONCEPTS OF RADIATION PROTECTION MECHANISMS. Baraboi, V. A. Usp. Sovrem. Biol., 58: 52-73(July-Aug. 1964). (In Russian)

A state-of-the-art review (300 references) of theories of radiation protection mechanisms at the atomic-molecular level, the cell level, and the organism level is presented. (IIC-M.G.)

## Radiotherapy and Radiodiagnosis

*Refer also to abstract 32251.*

**31929** (ACRH-23(p.10-20)) A RADIOISOTOPIC DEVICE FOR MEASURING BONE MINERAL. Lanzl, L. H. (Argonne Cancer Research Hospital, Chicago, Ill.); Strandjord, N. M. (Chicago Univ., Ill.).

An instrument using radioactive iodine-125 was devised for non-destructive testing to determine the condition of the bone mineral in the skeleton. This is accomplished by studying the transmission through a single finger bone of the radiation emanating from iodine-125. For small-animal work, a rear leg is used. The smaller the bone mineral content, the higher will be the transmission of the radiation through the bone. A lower value of bone mineral content may be due to a thinner bone, a bone of lower density, or a combination of both. A change in the effective atomic number of the bone will also result in a change in the radiation transmitted through it. Data are summarized for 90 patients. The effects of hormone therapy were evaluated in patients with postmenopausal osteoporosis. (C.H.)

**31930** (NYO-3267-2) USE OF ISOTOPES AND SLOW NEUTRONS IN DIAGNOSIS AND TREATMENT OF NEOPLASMS. (Massachusetts General Hospital, Boston. Physics Research Lab. and Massachusetts General Hospital, Boston. Neurosurgical Service). [1965]. Contract AT (30-1)-3267. 45p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Recent developments are reported in the use of ultra short-lived positron-emitting radioisotopes with a camera-type scintillation detector for the localization of tumors. The advantages of 6-hr $^{99m}$Tc and 1.8-hr $^{18}$F for rapid diagnosis and low radiation dose to the patient are discussed. Results are summarized from investigations of the use of $^{10}$B-neutron capture reactions for the selective destruction of infiltrating gliomas in selected patients. Results indicate this mode of therapy combines some of the most attractive features of external radiation therapy and internal isotope therapy. A number of boron compounds were synthesized and evaluated in mice for their selective deposition in tumors. Data are included on boron analogs of biologically-important compounds, B-containing antibodies, and miscellaneous B compounds. The development of thermoluminescent dosimeters for $\gamma$ dosimetry and solid state probes using LiF plastics or $H_3BO_3$ as powder or solutions in water for the detection of $\alpha$ particles from $^{10}$B is discussed. Neutron spectra were measured by threshold foil activation and converted to a differential dose spectra by use of dose-flux relationships. A computer was used in reactor neutron dose calculations and a code was developed for the IBM 7090 for the calculation of neutron spectrum and total neutron dose. The code gave excellent results with a minimum of input data and computer time when used for dose calculations on the Medical Beam Facility of the M.I.T. reactor. (C.H.)

**31931** (NP-tr-1237) THE POSSIBILITY OF REDUCING THE RADIATION DOSE IN RADIO-DIAGNOSIS. Gregorio, G. Translated by Whitston, O. S. (Atomic Energy Research Establishment, Harwell (England)), from Atti, Congr. Nazl. Radiol. Med. Med. Nucl., 22, Catania, 1963, 484-93. 21p. (Includes original, 9p.). Dep.(mn); $2.60 (fs), $0.83(mf) JCL.

The development of x ray equipment for use in diagnostic radiography is discussed. Emphasis is placed on the development of x-ray tubes and image intensifier systems that would result in reduced radiation dose to the patient. (C.H.)

**31932** RESULTS OF THE SURGICAL AND RADIOLOGICAL TREATMENT OF CARCINOMA OF THE CERVIX AT THE WOMEN'S CLINIC, UNIVERSITY OF HELSINKI, IN 1953-1958. Turunen, A.; Vara, P. (Univ. Central Hospital, Helsinki). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 62-7(1965).

A survey is given of 741 cases of cervical cancer treated by various types of radiation with a discussion of doses used, clinical results, complications, and of possible means for improving results and reducing complications. Since 1951, $^{60}$Co has been used in addition to radium. Radium treatment was given 3 times at a fortnight's intervals, and x irradiation was begun immediately after the third treatment. The development of fistulas after the treatment was comparatively rare in the cases studied. In patients treated by irradiation, rectovaginal fistulas appeared in 15 cases, or 2.3%, and vesicovaginal fistulas also in 15 cases, or 2.3%. In patients treated by surgery, rectovaginal fistulas occurred in one case, or 1.1%, ureterovaginal fistulas in 2 cases, or 2.3%, and vesicovaginal fistulas in 2 cases, or 2.3%. The results obtained by radiological treatment of carcinoma of the cervix during the years 1953–1958 indicate a slight improvement on the results recorded from previous years. In cases of carcinoma of the cervix of stages from I to IV in which the patients were treated by irradiation with the Mueller convergent moving apparatus, the incidence of five-year curves was 57.2%. It has furthermore been possible to achieve more exact doses with radium and x irradiation, and to provide at the same time,

better protection for the rectum and the bladder. By using the extended Wertheim operation with lymphadenectomy in combination with a more efficacious x-ray treatment it has also been possible to improve the prognosis in cases of carcinoma of the cervix of stages I and II. (TCO)

**31933** COMBINED RADIOLOGICAL-SURGICAL TREATMENT OF CARCINOMA OF THE UTERINE CERVIX. Cullhed, S.; Eriksson, G.; Holmberg, N. G. (Karolinska Sjukhuset, Stockholm). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 75-8(1965).

Along with clinical results, some experimental work is described on the effect of x rays on lymph nodes in the mice. Unirradiated nodes may show the same histological picture as irradiated. The surest sign of radiation effects on the nodes was the granulation of the mast cells. This sign could be detected after 24 hr and remained for 6 weeks. This finding may be important for judging the pathology of the nodes found in specimens after postradiological operation. Also studied was the barrier function of the nodes, using human erythrocytes, toad erythrocytes, and Walker carcinoma cells. The barrier function diminished postirradiation after 2 weeks and was reduced to 25% after 7 months. From the clinical point of view it was interesting that an injection of Walker carcinoma cells into an afferent vessel, distally to irradiated node, gives higher frequency of metastasis in the lungs than in the control group. The condition was that the injected vessel passed directly, without anastomosis, into the node. This was confirmed by lymphangiography. The interpretation of value to clinical management is that operation after irradiation treatment should not be done too long after irradiation. (BBB)

**31934** CARCINOMA CERVICIS UTERI. Dahle, Thor (Ulleval Hospital, Oslo). Acta Obstet. Gynecol Scand., 43: Suppl. 7, 79-81(1965).

Surgical findings and complications are reported for 96 patients treated by combined irradiation and surgery. (BBB)

**31935** COMBINED RADIATION AND SURGICAL TREATMENT OF CARCINOMA OF THE UTERINE CERVIX IN MALMO: RECOVERY RATE, COMPLICATIONS. Gynning, I.; Lundgren, N.; Svennerud, S. (General Hospital, Malmo, Sweden). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 82(1965).

In the years 1949 to 1962, 457 cases of carcinoma of the uterine cervix were treated; 289 patients (63.2%) received a combination of radiation and surgical therapy, 156 (34.1%) had radiation alone, 5 had surgery alone, and in 7 cases no treatment was given. After 3 radium applications (6800-7200 mg-hr, depending on the spread of the tumor) and external irradiation from anterior-posterior fields (1200-2400 R to skin on all fields), radical hysterectomy with pelvic lymphadenectomy was done 2 months following radiation treatment (1949-1951 only radical hysterectomy). The 5-year survival in those who received combined treatment was in Stage I 86% and in Stage II 66% (the 5-year survival in the entire material was in Stage I 84.7% and in Stage II 60.5%). The rate of positive lymph nodes in Stage I was 12.2% and in Stage II 24.5%. Out of 34 cases who showed remaining tumor tissue in uterus and/or lymph nodes when operated on, 14 (41%) reached 5-year survival. Primary operative mortality occurred in 4 patients out of 289 (1.4%). In 2 cases radiation damage was severe. (BBB)

**31936** RADICAL OPERATION OF CERVICAL CANCER: TECHNIQUE AND PRIMARY RESULTS. Holmberg, N. G.; Eriksson, G.; Cullhed, S. (Karolinska Sjukhuset, Stockholm). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 83-4 (1965).

group, 22 cases, the operation was primarily scheduled to take place 4-6 weeks after two initial radium treatments; while the second group, 10 cases, consisted of local recurrences or poor initial response to irradiation, who were later referred to operation. Two observed cases of combined recto- and vesico-vaginal fistulae had heavy irradiation and bladder and bowel symptoms already before operation. A third fistula was presumably of traumatic origin and healed spontaneously after 3 months' treatment with indwelling catheter. In two cases, relaparotomy was performed 7 days after operation because of intestinal obstruction. (BBB)

**31937** LATE RADIATION REACTIONS IN CANCER OF THE CERVIX. Bergsjo, Per; Evans, John C. (Norwegian Radium Hospital, Oslo). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 90-6(1965).

Descriptions are given of 41 cases of radiation injury among 933 patients treated for cervical cancer. The treatment included Ra, 170-kvp x rays, and 31-Mev $\beta$ rays. In addition to 41 serious complications there were three cases of fracture of the femoral neck. Most were localized in the rectum, followed by bladder, while vaginal vault necrosis and small bowel lesions were rare. One case of death following irradiation was attributed to small bowel perforation, and one to ulcerative colitis. The patient with colitis was treated with radium plus 170-kvp x rays, the other with radium alone. The time of onset of symptoms following radiation is shown. Although the rectal complications followed a definite pattern, with the majority of lesions appearing during the second half year, the bladder lesions followed no particular pattern. The rate of complications seemed to be about the same in stage I and II, while stage III had a much lower rate, possibly due to the rapid fall in survival rates of this group, not allowing time for the complications to develop. With the exception of the complication rate in the radium-plus-betatron group, which consisted of only one patient with complications, there was a definite correlation between the dose and time on one hand, and the survival and complication rates on the other. It was noted that the radium delivered over five days seemed to have a higher biological effectiveness than the same dose given over ten days, showing the importance of the dose-rate in local radium treatment. The treatment of the radiation complications was, on the whole, symptomatic. Grade II lesions generally improved and healed under conservative treatment, while some progressed to become fistulas. Two of the six rectovaginal fistulas closed spontaneously. (TCO)

**31938** OPERATION FOR COMBINED RECTO-VAGINAL AND VESICO-VAGINAL POST IRRADIATION FISTULA. Ostergaard, Erling (Frederiksberg Hospital, Copenhagen). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 97(1965).

Two cases were observed and successfully treated, one 18 months and the other 8 months after irradiation treatment for uterine cervical cancer. The operation was performed in two stages: first, colostomy and second, colpocleisis. Between the 1st and 2nd stage was an interval of 2-3 months allowing healing of the vagina. In colpocleisis the anterior and posterior walls of vagina, after removal of the mucosa, were united from just under the lower border of the fistulae in an extension of 4-5 cm. Permanent bladder drainage with suction and antibiotic treatment for 10 days resulted in primary healing. As a result of the operation the bladder and the rectum, united by the fistulous channel above the colpocleisis, formed a combined receptacle for urine, and the patients were continent, voiding the urine voluntarily 3-5 times a day per anum. The first patient died later from distant metastases but was greatly relieved by the operation; the second patient is still alive in good condition 4 years after the irradiation treatment. (BBB)

**31939** OXYGEN TENSION AND RADIOCURABILITY IN CANCER OF THE CERVIX. Kolstad, Per (Norwegian Radium Hospital, Oslo). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 100-2(1965).

Attempts were made to assess to what extent the vascularization and oxygen tension of cancer of the cervix affects the radiocurability of this malignancy by studying 30 cases of benign lesions, 51 cases of dysplasia, 109 cases of carcinoma in situ, 32 early invasive cancers, and 185 invasive cancers of the cervix. The vascularization of the tumors was studied by colpophotography. The blood oxygen tension in capillary blood samples from the tumors was

determined by a spectrophotometric method, and tissue oxygen tension in the tumors was determined by a polarographic method. The parameter found to be of greatest significance for the evaluation of vascularization of different lesions was the largest intercapillary distance, as measured in the colpophotographs. In invasive squamous cell carcinoma of the cervix, the intercapillary distance showed a definite and progressive increase during the more advanced stages of the disease, as did the occurrence of small, superficial necrosis. Cancerous blood and tissue oxygen tension showed a decrease in the later stages of the disease. Tumors with decidedly hypoxic or anoxic foci were found more frequently in the more advanced stages of the disease. Breathing of pure oxygen resulted in a rapid and large increase in tissue oxygen tension in the controls. In carcinoma in situ the increase was slightly slower and less marked, and the smallest increase was found in invasive carcinomas. In 7 Stage II lesions with local recurrence, the tissue oxygen tension was markedly lower than in 13 Stage II lesions with no signs of new growth. No increase in tissue oxygen tension on oxygen breathing was observed in tumor areas of 4 out of 6 cases with local recurrence within one year as compared with only 2 out of 18 cases with no signs of recurrence. A statistically significant correlation between the presence of tumor areas with a larger intercapillary distance than ~350 $\mu$ and local recurrence within one year was found. Thus there exists a definite relation between a poor vascular supply, i.e., between a low tissue oxygen tension, and radioresistance in cancer of the cervix. (TCO)

**31940** PHYSICAL ASPECTS ON THE EXTERNAL IRRADIATION OF CARCINOMA OF THE CERVIX. Ranudd, Nils Erik (Radiofysiska Institutionen, Stockholm). Acta Obstet. Gynecol. Scand., 43: Suppl. 7, 117(1965).

The biological effects of ionizing radiation are caused by the energy absorbed in the irradiated tissue. When comparing different irradiation techniques, as well as precalculating a wanted radiation effect, attention must be paid to the energy absorbed in the tissue. Dose distributions therefore should be expressed in absorbed dose (rad). The dose from intracavitary radium applicators decreases very rapidly with the distance from the source, so that the dose at the pelvic wall (point B) will be only about 25% of the dose 2 cm from the center of the source (point A), which is not high enough. The dose distribution from two opposed beams will be very inhomogenous. The min dose is in the middle of the body. With conventional x rays the dose in the small bowel and the rectum will be about twice that in point B for a 20-cm thick patient. Dose distributions depend very much on the anterior-posterior dia. To get the same dose at point B, a patient with a 25-cm dia must be given an 80% (30% with $^{60}$Co) higher dose than a patient with a 15 cm dia. The relative biological effect of the conventional x rays is, however, 10 to 20% higher than that of $^{60}$Co $\gamma$ radiation. With a three-field technique with one anterior and one wedge-filtered beam from each side it is possible to get a much better dose distribution. The max dose is placed in the tumor volume, and the dose decreases rapidly outside tumor. (BBB)

**31941** HYPERTHYROIDISM AS VIEWED BY AN INTERNIST. Pittman, J. A., Jr. (Medical Coll. of Alabama, Birmingham). Alabama J. Med. Sci., 1: 49-59 (Jan. 1, 1964).

Reasons are advanced for the concept that radioiodine provides the best treatment for hyperthyroid patients over age 40, and evidence for and against the possible radiation hazards to patients through the use of radioiodine is examined critically. No form of treatment available today seems to get at the basic difficulty in these patients, and ablation of part of the thyroid gives only symptomatic relief, although some of these patients do show a return of the normal suppressibility of the thyroid-pituitary axis after such treatment. There is no question about the efficacy of radioiodine in selectively ablating thyroid tissue and leading to remissions just as effectively as does surgery. Aside from the question of determining the proper dose, the main question about radioiodine treatment is whether or not it is safe, i.e., what is the radiation hazard to the patient from the doses of radioiodine commonly used in treating hyperthyroidism—about 4 to 8 mC? An absolute answer to this question is not possible at present, but there are certain indications that the hazard is very low if not negligible. The problems fall into three areas: (1) leukemia, (2) thyroid carcinoma, and (3) genetic damage. There have been two extensive studies of the incidence of leukemia in patients who have been treated for hyperthyroidism with radioiodine. Although the proportion of acute to chronic cases of leukemia is somewhat high, and although these series have probably overestimated the number of treated cases, they provide fairly good evidence that there is no increased incidence of leukemia after radioiodine in these doses. This is almost certainly not true in the case of doses of several hundred mC as are used in the treatment of thyroid carcinoma, but such enormous doses are greatly in excess of those under consideration here. There are no adequate studies of the incidence of thyroid carcinoma following $^{131}$I treatment of hyperthyroidism, but cases have been reported in which the association of multiple treatments with radioiodine and the subsequent development of thyroid carcinoma seem suspicious. In one case the patient was a 9-yr-old girl when first treated and was found to have carcinoma 8 yr later. Other suggestive evidence comes from the finding that about 80% of a larger series of children with thyroid carcinoma gave a history of some sort of irradiation to the neck region in the past. This high incidence again indicates some relation between the radiation and the subsequent carcinoma. It is pointed out, however, that subtotal thyroidectomy has also been reported to increase the incidence of carcinoma in the thyroid remnant, presumably by evoking an increased secretion of thyroid-stimulating hormone (TSH). Apparently children are more susceptible to such damage than are adults, and animal experiments have shown that sensitivity to radiation damage is greatest in young and extremely old individuals. The problem of genetic damage is even more difficult to solve. Published data indicate that detectable chromosomal abnormalities can occur in the leukocytes of patients treated with several hundred mC of $^{131}$I for thyroid carcinoma. However, similar studies for doses of the size used in hyperthyroidism are not yet available; and, in any case, failure to detect such changes will not be as conclusive as finding them. But it is possible to compare the amount of radiation received by the gonads, for example, from commonly employed diagnostic x-ray procedures and from radioiodine. This shows that the doses from $^{131}$I, while generally slightly higher than those from the diagnostic x rays, are not inordinately so. The gonadal dose from $^{131}$I under these circumstances is about 1 to 6 rad delivered over less than one month, while a barium enema x-ray study gives about 0.25 rad in the female and about 0.04 in the male; hip x rays give 0.4 rad in the female and 2.1 rad in the male. Thus, if the genetic damage from $^{131}$I is a hazard, hip x rays should not be taken. There are counter-arguments (e.g., $^{131}$I radiation involves the whole body to some extent), but the point is a strong one in favor of radioiodine. Favoring the use of radioiodine in hyperthyroidism, is the fact that there has never been a case of permanent recurrent laryngeal nerve damage reported and that there has never been a well-documented case of permanent hypoparathyroidism. Immediately post-treatment deaths from exacerbation of the hyperthyroidism, if they occur at all as a result of the $^{131}$I, do not occur if severely thyrotoxic patients are first prepared with antithyroid drugs. (BBB)

**31942** OSTEORADIONECROSIS. Webster, James R. (School of Dentistry, Univ. of Alabama, Birmingham). Alabama J. Med. Sci., 1: 209-10(Apr. 1964).

The pathogenesis, diagnosis, treatment, and prevention of radioinduced necrosis of bone, as seen in dentistry, are reviewed. As a complication occurring after radiation therapy of cancer, the mandible and maxilla are the two most commonly involved bones. The etiologic factors are radiation, trauma, and infection, the irradiated bone ex-

hibiting decreased blood supply, destruction of marrow, and depression of osteoblasts which impair the viability of the bone. Trauma or extraction of teeth from the irradiated bone area may provide for bacterial entrance, resulting in progressive breakdown of bone and overlying mucosa with development of osteoradionecrosis. The time interval between irradiation and osteoradionecrosis varies from weeks to years. At the first symptom the pain may be so intense as to cause interference with mastication and/or debilitate the patient, which in turn will cause poor nutritional status. Inspection may reveal a devitalized area of mucosa or periosteum. The one universal clinical finding is the presence of exposed bone, which may lead to further extension of the infection process causing extensive cellulitis of the face and neck. Trismus frequently occurs in osteoradionecrosis, and may be partial or complete. It may be due to presence of infection or to secondary effects of radiation such as scarring. Radiation necrosis leads to marked destruction of the mandible rendering it very susceptible to pathologic fracture, which may present as a sudden severe pain and numbness of the skin on the affected side or may become evident only on radiographic study of the case. Various methods used to attempt to prevent osteoradionecrosis include fractionation of dosage, high protein diet, lead shielding, and good oral hygiene. Extraction of teeth in the area or teeth with extensive alveolectomy greatly decreases the rate of occurrence of osteoradionecrosis. There are two treatments; nonsurgical or conservative treatment, which should be reserved for patients with minor and relatively non-painful areas of osteoradionecrosis. It consists of medication for pain by analgesics and nerve blocks, antibiotics to combat infection, and self-cure by sequestration. The second method consists of sequestrectomy with saucerization, intra-oral resection with adequate margins which assure removal of all the diseased bone. (BBB)

**31943** PROFESSIONAL AND CONTINUING EDUCATION IN RADIOISOTOPE UTILIZATION. Luick, Jack R. (Univ. of California, Davis). Am. J. Vet. Res., 26: 566-70 (Mar. 1965).

The usefulness of radioisotopic techniques in veterinary medicine is cited, with reference to numerous applications, examples of which are mentioned. These examples illustrate some of the special advantages of tracer techniques over the more conventional chemical and histologic methods. However, there are disadvantages. Equipment is costly, and radioactive waste must be disposed of. Furthermore, the veterinary practitioner must be trained in radioisotope technique to meet the licensing requirements of the Atomic Energy Commission, and even then he is restricted to work with short-lived isotopes. Experiments conducted in the author's school of veterinary medicine include $^{14}$C-glucose and $^{131}$I being used to investigate the glucose metabolism and thyroid function of hibernating bats, and $^{35}$S-sulfate and tritium-labeled thymidine to study the growth of cartilage. Also, $^{59}$Fe and $^{51}$Cr were used to study the life span of sheep red blood cells in experimental anaplasmosis and in parasitic gastroenteritis; and $^{131}$I-labeled antigen was used to measure the rate of antibody formation and clearance of antigen from rabbit blood. A large, AEC-financed, research project is in progress dealing with the biological effects of $^{226}$Ra and $^{90}$Sr in beagle dogs; $^{14}$C-, deuterium-, and tritium-labeled metabolites have been used in research on the metabolic pathways of milk formation in normal ketotic dairy cows; $^{14}$C-labeled amino acids were used to investigate enzyme synthesis during hepatic insufficiency; electrolyte metabolism was studied with $^{22}$Na and $^{40}$K in normal and toxemic sheep; and $^{14}$C-labeled enothal was given in feed to follow the metabolism of that herbicide in sheep. Muscular dystrophy is being studied in sheep, using $^{75}$Se-selenate, and the passage of various $^{14}$C-labeled substances is being traced across the placental membranes of sheep. Radioactive tracers are also used in developing diagnostic procedures in the field of clinical medicine. Radiocarbon was also applied as a label for glucosamine in studies on the metabolism of ovine serum glucoproteins; $^{14}$C-glucose and $^{14}$C-acetate made possible research on the intermediary metabolism of a dairy cow suffering from diabetes mellitus; and $^{14}$C-labeled adenine, tritium-labeled thymidine, and radiophosphorus are currently used to study leukocyte turnover in bovine leukemia. In addition, $^{14}$C-glycine, $^{59}$Fe-citrate, and $^{51}$Cr-chromate are being used to study red blood cell life span during bovine porphyria erythropoietica, experimental molybdenosis, canine anemia, bovine polycythemia, hypoxia, and in a comparative study using domestic and wild sheep. There are at present only six veterinarians or veterinary hospitals licensed to possess radioactive materials in California, including four permits to use $^{90}$Sr applicators (for the irradiation of eye cancer in large animals), one permit for the use of $^{131}$I, and one permit for the use of Ra. Also considered are classes providing for student training in the fundamentals and measurement of radioactivity, radioautography, tracer methodology, dosimetry, biological effects, design of a radioisotope laboratory, procurement of isotopes, waste disposal, radiation safety, and in tracer experiments in soil, plant, animal, and microbiologic research. (BBB)

**31944** ANESTHESIA BY REMOTE CONTROL DURING RADIATION THERAPY. Cullen, Stuart C. Anesthesiology, 24: 112-14(Jan.-Feb. 1963).

Some problems of giving anesthesia during neutron radiation treatment of intracranial tumors with the reactor at the Massachusetts Institute of Technology are described. Under general anesthesia a craniotomy is performed, a boron solution given intravenously, and the area of tumor exposed to neutron bombardment for 45 to 105 min. Surgical anesthesia is required throughout craniotomy and the subsequent exposure to as much as 30,000 R. During this period the patient has to remain in the room unattended. He is separated from the surgical and anesthetic team by lead lined walls 4.5 ft in thickness and an overall distance of about 20 ft. The patient can be observed at this distance through an oil-filled window in the wall. During the neutron therapy the patient (and operating table) are elevated to the ceiling where the portal from the reactor is located, a height of about nine ft. The anesthetic technique must be nonexplosive. It is administered through a non-rebreathing valve connected by a 30-ft wide-bore (2-in) non-kinkable tube from an anesthesia machine outside the room. The tubing is led through a Z-shaped tunnel in the wall of the room. This method was used in 16 cases without any anesthetic complications. Blood pressure, pulse rate, and pulse rhythm are accurately monitored with a remote system. When the craniotomy is completed and the boron solution administered, the anesthesia machine is moved from the room to a point outside the window. After all apparatus is connected and checked, all doors are closed, the radiation portal opened, and neutron bombardment begins. A study of the effect of proton bombardment on radiosensitive brain tumors at the Harvard University Cyclotron Lab is also reported. Four children received this type of treatment under general anesthesia, required only to prevent movement. There are two main differences between the reactor and the cyclotron in relation to the administration of anesthesia. At the cyclotron closed circuit television is used to observe the patient, and instead of one prolonged bombardment, exposure was divided into 5 to 10 three-min periods. (BBB)

**31945** UNTREATED CHRONIC MYELOCYTIC LEUKEMIA ASSOCIATED WITH AN UNUSUAL CHROMOSOME PATTERN. Houston, Elsie W.; Levin, William C.; Ritzmann, Stephen E. (Univ. of Texas, Galveston). Ann. Internal Med., 61: 696-702(Oct. 1964).

The possible association of diagnostic radiation exposure with subsequent development of leukemia, in association with unique chromosome changes, is considered. The subject is a white female patient with chronic myelocytic leukemia which has progressed very slowly and not yet required treatment. The patient, 48-yr-old, had a 5-yr history of gastrointestinal distress upon the in-

gestion of certain foods. Diagnostic gastrointestinal x rays and two chest x rays were performed within the 2-yr period preceding the onset of the present illness and constitute the only known exposure to radiation. Peripheral blood cells were cultured three times for chromosome studies. Of 22 cells counted on squash preparations, 21 cells had 46 chromosomes, and one was a tetraploid cell. One karyotype demonstrated a questionably small number 21 chromosome. Peripheral blood was cultured six months later and yielded 25 cells with 46 chromosomes, one with 45, and one with 44 chromosomes. One cell exhibited a questionably small number 21 chromosome. Karyotype analyses were made of seven cells including a near tetraploid cell. All cells but one had one small chromosome of group G, which was interpreted as a probable $Ph^1$ chromosome. There were two of these in the near tetraploid cell. All of the cells counted had one distinctive submetacentric chromosome longer than any other in the cell. There were two of these in the hear tetraploid cell. In each cell karyotyped one chromosome of the normal complement was missing with no pattern of consistency. Every group was involved with the exception of the acrocentrics of groups D and G. The chromosome patterns reported are characterized by: pseudodiploidy; consistency of the presence and morphology of a single distinctive submetacentric chromosome longer than any normal chromosome in the cell; and the absence of one chromosome of a normal pair with no pattern of consistency except in the failure of this chromosomal absence to involve either of the acrocentric groups. However, it is impossible to be certain whether or not the previous diagnostic x-ray procedures had any bearing on the chromosomal abnormality described. (TCO)

**31946** FIVE-YEAR RESULTS IN 431 BREAST CANCERS TREATED SOLELY BY ROENTGEN RAYS. Baclesse, Francois (Universite, Paris). Ann. Surg., 161: 103-4(Jan. 1965).

The results, especially the cure rate and complications, obtained with conventional x-ray therapy were compared to those seen previously with $^{60}Co$ and other modes of radiotherapy. The 431 patients with breast cancer were treated only with 200-kv x rays. All diagnoses were verified histologically. Of 56 patients in Stage A, 27 (54%) and of 86 patients in Stage B, 58 (67%) were living after five years. This difference in the results of treatment between Stage A (54%), which should theoretically be the most favorable class, and Stage B (67%) could not be explained. Stage C included 95 patients, with a survival rate of 41%. Stage D included 200 patients of which 27 (13%) survived five years. This kind of x-ray therapy depends upon administration of large doses which radioresistant tumors require and also upon the use of multiple fields. Six fields were used and in exceptional cases seven or eight, distributed over the very large area that has to be irradiated. This area included the mammary gland, pectoral region, and all of the regional lymph nodes (axillary, supraclavicular, and internal mammary). It was necessary to fractionate the irradiation to a high degree to make it possible for the tissues to tolerate these very considerable doses, even though the area to be irradiated was subdivided. The irradiation was given every day, Sunday excepted. The overall time required was considerable, varying between three and four months with the classical voltage of 200 kv. Cobalt-60 was found to be advantageous in improving the local and regional results; but since statistics of end results depend to a great extent upon the frequency of the phenomenon of blood-borne metastases, it is possible, even probable, that long-term end results of 5 and particularly 10 and 15 years, will not be improved by $^{60}Co$ therapy. Patients may succumb to their distant metastases even though their local and regional condition is good. (BBB)

**31947** COMPARATIVE BIOLOGY AND DOSIMETRY OF CONVENTIONAL RADIATIONS AND FAST ELECTRONS. Zuppinger, A. (Radiologisches Institut, Inselspital, Bern). Arch. Klin. Exptl. Dermatol., 219: 439-50 (June 25, 1964). (In German)

Fast electrons have physical characteristics that make them particularly advantageous for treatment of malignant tumors. To date, experimental studies have not demonstrated any qualitatively different effects of fast electrons, but they do show very favorable differences in their relative biological effectivity (RBE). They give values for collisions produced that are quantitatively similar to those produced by conventional x irradiation, but fast electrons are less effective in organs and animals as a whole. While several studies of their effects on tumors indicate favorable effects, the superiority of fast electrons in tumor therapy has not been experimentally established for certain. However, clinical observations show a number of notable differences. It is possible to alter several tumors that to now have been radioresistant. Tumors in radiosensitive areas can be treated by fast electrons. Recurrences in irradiated areas can be affected more with fast electrons than with other irradiations. Furthermore, when fast electrons are used for preoperative irradiation, there are fewer complications. The various mechanisms of effect of fast electrons can be made clear by bubble chamber studies. (BBB)

**31948** CURRENT RESULTS IN THE TREATMENT OF DERMATOLOGICAL DISEASES WITH FAST ELECTRONS. Bode, H. G. Arch. Klin. Exptl. Dermatol., 219: 450-8 (June 25, 1964). (In German)

The therapeutic superiority of fast electrons as compared to conventional x irradiation is very closely related to the differences in dose distribution of the two types of irradiation within the tissues. An additional advantage of electron irradiation is the fact that dose received when it is absorbed in bone falls off very rapidly as compared to the bone dose from x irradiation. This is very important in treatment of tumors located adjacent to the skeleton. In treatment of malignant melanomas a five-yr survival rate of about 60% was observed after treatment of localized tumors with fast electrons. In treatment of more widespread melanomas the five-yr survival rate was about 25%. It is important to irradiate a wide field of tissue in order to ensure inclusion of the regional lymphatic bed. A dose of from 6000 to 7000 R is necessary to produce regression of the tumor so that it can be resected. Another use for treatment with fast electrons that is encouraging is squamous cell carcinoma of the skin. (BBB)

**31949** RADIOACTIVE ISOTOPES IN DERMATOLOGICAL RESEARCH AND DIAGNOSIS. Wiskemann, A. (Universitaets-Hautklinik, Hamburg). Arch. Klin. Exptl. Dermatol., 219: 458-73(June 25, 1964). (In German)

The author reviews applications of radioisotopic procedures to diagnosis of dermatological diseases and disorders. Measurement of peripheral tissue clearance is performed with monatomic ions such as Na, Br, or I. This test measures only the blood flow through the capillaries that do not have arterio-venous anastomoses. However, capillary permeability may also be measured at the same time. Skin permeability and resorption tests measure the diffusion characteristics of skin in vivo, but this can also be measured in perfused or excised skin. This test has been used to measure absorption of various salve bases and noxious chemicals. Allergic reactions have been studied with $^{131}I$ labeled antigens, antibodies, and complement. For longer term studies $^{14}C$, $^{35}S$, and $^{3}H$ have been used. Tumor diagnosis with $^{32}P$ has been proven to be useful for detection of melanocytoblastoma, juvenile melanoma, melanotic precancerous lesions, pigmented naevi, seborrheic warts, angiomas, fibromas, epitheliomas, and sarcomas. (107 references). (BBB)

**31950** CARCINOMA OF THE LUNG: RESULTS OF SUPER VOLTAGE RADIATION THERAPY. Brady, Luther W.; Cander, Leon; Evans, George C.; Faust, Donald S. (Hahnemann Medical Coll., Philadelphia). Arch. Surg., 90: 90-4(Jan. 1965).

Reasons for use of radiotherapy rather than surgery in selected cases of lung cancer are discussed and results of the use of radiation in 70 patients are described. Sta-

tionary external beam supervoltage techniques were utilized with the 2-Mev Van de Graaff generator. In planning the radiation therapy, the aim was to treat the entire visualized lung lesion as seen on the roentgenograms with an adequate margin of normal tissue surrounding the tumor mass. In those patients who were treated for cure, the treatment was planned so that 6000 rad would be delivered to the lung lesion in six weeks. In 42 patients treated for palliation, the treatment was planned so that 3500 rad would be delivered to the entire lesion with a normal border of surrounding tissue in 3.5 weeks. The treatment was given through anteriorly and posteriorly placed parallel opposed portals. Volume distribution of the dosage was calculated after localization. For palliative therapy the six-month survival was 31%; the 12-month survival was 19%; two-year, 7%; three-year, 5%. Of the 42 patients treated palliatively, the median survival following the completion of radiation therapy was four months. For definitive therapy the six-month survival was 71%; 12-month, 53%; two-year, 29%; three-year, 12% (5/28). Among the 28 patients treated for cure the median survival following the completion of the radiation therapy was 12 months. There were no significant complications to the radiation therapy as administered for palliation or cure. There was subjective improvement in symptomatology in most patients. There were roentgenographic evidences of fibrosis and shrinkage of the lung in all of the patients who survived longer than six months. This was particularly true in those patients who received treatment for cure. The fibrotic changes did not normally cause symptomatology although there was occasionally cough and mild exertional dyspnea. The survival figures were best when the calculated tumor dose was greater than 5000 rad. The results suggest that a minimum of 3000 rad should be delivered to the tumor for effective palliation, and a min of 5000 rad for definitive therapy. It cannot be stated unequivocally that these doses represent minimums, since some patients did not survive long enough to receive the planned optimal dose. It is concluded that in carefully selected cases of carcinoma of the lung, tumor-sterilizing dosages of radiation can be safely given by well-planned supervoltage techniques with proper dose planning. It was also demonstrated that postoperative radiation therapy to unresectable or incompletely resected lesions can improve the salvage rate whether treated for palliation or cure. (BBB)

**31951** SCINTISCANNING THE THYROID NODULE: AN AID IN ITS SURGICAL MANAGEMENT. Gibbs, Jonathan C. Jr.; Halligan, Earl J.; Grieco, R. Vincent; McKeown, James E. (Jersey City Medical Center, N. J.). Arch. Surg., 90: 323-8(Mar. 1965).

The use of the scintiscan to evaluate the degree of functioning tissue of a nodule or nodules in the thyroid gland is described. Although other methods are available, with the use of a scintiscan, not only are the findings more specifically interpreted, but the function of a particular region can be studied as to the degree of uptake and the retention of $^{131}I$. These scintiscans can be repeated without undue hazard of radiation to the patient. The reproducibility of a scintiscan has been established, and the reliability of uptake differentiation is being constantly improved with improvement of technique and equipment. The scintiscan can thus be used to depicit in vivo, with no hazard or discomfort to the patient, the topographical thyroid function ($^{131}I$), uptake, and storage, before, during, and after medical or surgical therapy. This study includes 2000 patients with or without clinically demonstrable nodule(s) in the thyroid which were scintiscanned. They were also evaluated with $^{131}I$ uptake, conversion ration, protein-bound iodine, and basal metabolism tests when necessary. Clinical examinations and x rays of the chest and neck were also made to determine the presence of enlargement, calcification, or tracheal pressure by the thyroid. The results confirm that the scintiscan affords the best means of determining if a nodular area of the thyroid gland is functioning and the degree of function present. Nodules can be classified as being functioning, hyperfunctioning, or nonfunctioning. Nonfunctioning nodules may represent cysts, scars, benign tumors, or carcinoma. Thyroid-stimulating hormone and the scintiscan are of value in determining if the nonfunctioning nodule is malignant. Nonfunctioning (cold) nodules which do not respond to thyroid-stimulating hormone should be removed surgically. Toxic adenomas are effectively treated with $^{131}I$. Patients with metastatic carcinoma from the thyroid, after surgery and x-ray therapy, should be scanned before and after thyroid-stimulating hormone administration in order to determine if $^{131}I$ therapy is of value. (BBB)

**31952** RADIOTHERAPY OF THE SKIN RETICULOSES. Szur, Leon (Hammersmith Hospital, London). Brit. J. Dermatol., 76: 10-20(Jan. 1964).

Theoretical and practical aspects of treatment are discussed, with attention to a wide variety of radiation sources, suggested optimal doses, and clinical results. Reticuloses in general, but especially the skin reticuloses, are among the most radiosensitive tumors known. Recent experimental work confirmed that mammalian and tumor cells exposed to radiation survive in a prescribed manner, when the surviving fraction of cells is plotted on a logarithmic scale against the dose in rad on an arithmetical scale that there must be important factors involved in the eradication of skin reticuloses that affect the viability of viable cells and that may act in conjunction with, or affect the response of these tumors to radiation. If immunological factors as well as radiation do play a part in the response of the tumor, then these factors may become ineffective or operate to a lesser degree as the disease advances. The penetration of the radiation used and the dose to be applied should be kept as low as possible, consistent with the aim of obtaining a satisfactory remission for a reasonable period. Of the radiotherapeutic techniques available, only external radiation has proved reliable. The treatment of lymphocytoma cutis, lymphosarcoma or reticulosarcoma of the skin, and mycosis fungoides is discussed. It is suggested that the solitary lesions of lympho- or reticulosarcoma should receive radical treatment. The use of 8-Mev electrons in the treatment of reticuloses involving the greater part of the body surface is described in detail, and the results in 16 patients are analyzed. It was concluded that at present radiotherapy is the most effective form of treatment both for palliation and the prolongation of life in patients with cutaneous reticuloses. (TCO)

**31953** RADIATION MYELOPATHY. British Med. J., 1: 469(Feb. 20, 1965).

Usually signs and symptoms of a localized lesion of the nervous system after radiotherapy for malignant tumor indicate a metastasis has developed, but the idea that the nervous system is tolerant to irradiation is not always true, and a new focal lesion in the brain or spinal cord may be related to the treatment. This relation is obscured by the almost invariable interval (from six months to two yr) between radiotherapy and the symptoms of damage to the tissues. Necrosis may occur in the optic chiasma and hypothalamus many months after radiotherapy has been given postoperatively to the site of a pituitary tumor. The resulting symptoms may simulate recurrence of the growth, or may be mistaken for hormonal insufficiency. Few such cases have been recorded, but if individual experiences were pooled a considerable number would probably emerge. The spinal cord is particularly at risk from radiotherapy of neoplasms of the upper respiratory tract, the posterior part of the tongue, thyroid, or neck glands. Signs of damage to the cord usually appear after an interval of from one to two years, and consist of spastic ataxia, the level of which is strictly related to the level of the therapy. Some cases progress for many months and then reach a static phase, while others progress to complete cord transection and death. Some patients develop mild symptoms soon after treatment, and although they appear to be due to lesions of the spinal cord, cleared up completely. The neurological manifestations can be divided into two types: the delayed progressive radiation myelopathy, already described, with grave disability and prognosis, and a transient radiation myelopathy which develops within six weeks to six months of treatment

and clears up within a similar period. The important symptoms in the latter type is a sensation resembling an electric shock that travels down the spine, into the thighs, and sometimes into the arms, when the patient flexes the head forwards. This is worse after exercise, is not accompanied by any neurological signs, and gradually subsides over several weeks. In the nervous system the main effects of irradiation are on the small blood vessels, producing arteriolar degeneration and secondary changes in the brain or cord. The total dose given, method used, and duration of treatment influence development of such lesions, though the dose that is safe for the nervous system but effective against the primary lesion is not yet certain. Furthermore, patients show wide individual differences in the degree of sensitivity of their nervous systems. This complication of radiotherapy is a rare but important hazard, and one which causes considerable diagnostic confusion. (BBB)

**31954** DEMECOLCINE FOLLOWED BY RADIOTHERAPY. Grant, Alan (Belfast City Hospital). Brit. Med. J., 1: 926(Apr. 3, 1965).

Additional observations are made on the recently reported use of the mitotic inhibitor demecolcine (and the related compound colchicine) to enhance the sensitivity of tumors of radiation. In 1950 it was noted, in treating a patient with leukemia, that there was a larger fall in the white-cell count when 2 mg of colchicine was given two hours before radiotherapy than when colchicine was given alone. In 1954, while testing the effect of colchicine in leukemia the author noted in two cases of chronic myeloid that deep x-ray therapy sharply accentuated the effect. This led to the suggestion that the summation of colchicine and radiotherapy was beneficial and that colchicine could be tried as a sensitizer to x-ray therapy. Colchicine inhibits mitosis in the bone marrow, commencing at one hour and increasing for six hours. The first two waves of dividing cells die and the third wave completes division after 24 hours. Efforts to use colchicine in neoplastic conditions had largely failed before because a sufficiently high dose could not be tolerated by mouth owing to its irritant action on the gastrointestinal tract. It was found that to get the full effect of colchicine it has to be given intravenously, and a dose of 2 to 2.5 mg in 10 ml of water given daily was tolerated for about a week. The drug effect was cumulative, and, if given for long periods, toxic effects (fever, weakness, pallor of the skin, and confusion) required temporary cessation of therapy. Now the better-tolerated demecolcine is available. (BBB)

**31955** MYXOEDEMA AFTER DEEP X-RAY THERAPY TO THE NECK. Markson, J. L. (Stobhill General Hospital, Glasgow); Flatman, G. E. Brit. Med. J., 1: 1228-30(May 8, 1965).

External irradiation of the thyroid gland was at one time the standard treatment for thyrotoxicosis, and the reported incidence of severe hypothyroidism after radiotherapy was 1.3% in a series of 305 cases. After treatment with radioiodine this complication is more frequent, and found to be 29% over a follow-up period of 10 yr. Its occurrence could be related to the dose of radiation relative to the size of the gland, and not to an autoimmune reaction. As a complication of deep x-ray therapy to the neck in nonthyrotoxic patients, however, hypothyroidism is very rare, and it was possible to trace only one case in the literature, in which it appeared six years after treatment of carcinoma of the larynx. Five patients are described here who developed myxedema after irradiation of the neck for reticuloses involving cervical lymph nodes, and for carcinoma of breast, esophagus, and nasopharynx respectively. These cases are reported because of the rarity of this complication, and because of the findings of thyroid autoantibodies in all instances. The doses of x rays (250-kv) estimated to have been delivered to the thyroid were 2625, 2500, 3650, 4000, and 4850 rad. Four of the patients described showed well-marked clinical evidence of hypothyroidism from four to 12 months after completion of radiotherapy, and although in the fifth patient the interval was three years, in all cases the thyroid gland was directly irradiated. Coincidence could be excluded, but it was considered likely that the development of myxedema was related to irradiation of the gland. The thyrotoxic gland is highly radiosensitive, and, using x radiation for the treatment of thyrotoxicosis, a dose of 1500 to 2000 R was previously shown to be sufficient. None of these patients, however, were thyrotoxic. The normal thyroid, on the other hand, is very resistant to radiation, and, using $^{131}I$ in the treatment of angina pectoris, it was found that the min dose necessary for ablation of the gland is between 30,000 and 40,000 rad. A comparable dose delivered by external irradiation would cause severe soft-tissue damage. The amount of x radiation received by the thyroid glands of these five patients (2625 to 4850 rad) was far below that usually necessary to destroy the normal gland. If, therefore, myxedema was related to radiotherapy, either the effect of irradiation was indirect or the thyroid glands were not normal initially. That myxedema was not a direct effect of irradiation is suggested by the finding of thyroid autoantibodies in the serum of all five patients. The serological findings were similar to those in spontaneous myxedema, which is believed to be of autoimmune origin. It was speculated, therefore, whether irradiation was a factor in the induction of an autoimmune reaction in these patients. There is no serological evidence that radiation can initiate an autoimmune reaction in the normal thyroid gland. It is possible that the thyroids of these five patients were not normal healthy glands, and that the malignant disease from which they were suffering may have rendered them susceptible to damage by radiation. An autoimmune reaction may thus have been initiated by the damage to the thyroid epithelial cells. An alternative possibility is that the mild trauma by x rays potentiated an inflammatory reaction to antithyroglobulin antibodies. Thus, if the thyroid glands in these patients were already the seat of focal thyroiditis, injury to the thyroid epithelial cells by radiation may have rendered them more susceptible to the action of thyroid autoantibodies; or, alternatively, damage by antibodies may have sensitized the cells to the effect of radiation. The apparent rarity of this complication may be explained by the greatly reduced lifespan of patients suffering from diseases for which irradiation of the neck is required. Possibly, minor damage to the thyroid may be more common than is realized, and shielding of the glands during x-ray therapy would be a simple precaution. (BBB)

**31956** TRANSPLANTATION OF A KIDNEY FROM A BROTHER TO SISTER. Woodruff, M. F. A.; Robson, J. S.; McWhirter, R.; Nolan, B.; Wilson, T. I.; Lambie, Anne T.; McWilliam, Joan M.; MacDonald, Mary K. (Royal Infirmary, Edinburgh). Brit. J. Urol., 34: 3-14(1962).

This case report describes in detail the use of ionizing radiation in attempts to depress the immune response to donor kidney. A specially constructed isolation unit was used to reduce the possibility of infection in the irradiated patient. Pre-operative whole-body irradiation of the patient is described. Two fields to each side were required to cover the whole length of the patient and the fields were allowed to overlap slightly so as to avoid any possibility of a gap occurring between them. Using a 2-Mev Van de Graaff apparatus, a maximum dosage of 200 rad was delivered to the trunk. The minimum central dose was 150 rad. With an incident dose rate of 9.7 rad per min the treatment of each field was completed in 17.5 min. The total overall treatment time was thus 70 min. Immediately after completion of the whole-body irradiation additional treatment was given to the spleen and to the right lower abdomen. Here anterior and posterior fields were employed and in both areas the max dose was 110 rad and the min dose 100 rad. The incident dose rate was 100 rad per min and the treatment time for each field was 50 sec. For several days before and after irradiation the patient was given chlorpromazine by mouth. Aseptic care was given following irradiation. The patient was nursed in a special air-conditioned isolation unit by a

team of six nurses, two of whom were on duty at a time. The unit was ventilated by filtered air under positive pressure so that the air flow was constantly from the patient's room to other parts of the unit. Renal transplantation was performed two days after irradiation. In the period between irradiation and transplantation the patient felt well and did not experience either nausea or vomiting, but during the first two days after operation she was nauseated and vomited. Some oozing developed from the site of the right nephrectomy and she was given two pints of fresh blood which had been irradiated (1000 R) in vitro with the object of killing immunologically competent leucocytes. The graft began to secrete urine before the operation had been completed, and produced 1060 ml during the first 24 hours, with a creatinine clearance of 8 ml/min. The subsequent functional activity of the graft is summarized and the hematological changes which followed the irradiation are also shown. Eleven days after operation the patient was given a further 50-rad whole-body irradiation because it was thought that the poor performance of the graft in comparison with that of one previous isogenic graft was probably due to the onset of an immunological reaction. The technique and dose rate were the same as for the pre-operative whole-body irradiation. In this case the immunological reaction against the graft appears to have been very mild and it is conceivable that if the patient had not succumbed to infection the graft might have functioned sufficiently well to keep her alive. The elaborate precautions to prevent infection from without proved to be remarkably effective. On the other hand, recrudescence of infection in the urinary tract, and invasion of the blood stream by an organism almost certainly forming part of the patient's normal flora, proved intractable to treatment and were directly responsible for the patient's death. This complication of infection from within seems likely to arise not only with irradiation but with any other procedure in which an attempt is made to induce a state of specific immunological tolerance of a homograft in a mature recipient by damaging and destroying immunologically competent cells prior to transplantation and then allowing regeneration to occur in the presence of the mass of antigen represented by the graft. (BBB)

**31957** CARCINOMA OF THE BLADDER TREATED BY EXTERNAL IRRADIATION. Dick, Donald A. L. (Cancer Clinic, Edmonton, Alberta). Brit. J. Urol., 34: 340-50 (1962).

The treatment of 122 patients with bladder cancer by radiation is described with data being given on doses used and complications resulting from irradiation. In addition, mention is made of the fact that of the 15 female cases of bladder cancer, two had previously received pelvic irradiation for menopausal bleeding. Cobalt-60 teletherapy was used in 105 cases and 250-kv x rays in 17. The majority were given 6000 to 6250 rad in 25 treatments over a five-week period. A few received 6500 rad in a similar time, or 6000 rad in the shorter period of 20 treatments. Where large fields were required, or the lesion was advanced and the patient's general condition poor, 5500 rad in 20 or 25 treatments was prescribed. Palliative therapy consisted of 4500 rad given over four weeks. Where the disease was more advanced 3500 rad in 15 treatments was usual. During treatment most patients developed urinary frequency and discomfort. This started about the second week, becoming maximal around the fifth week and slowly disappearing over the next month. Diarrhea was not frequent, and true radiation sickness uncommon. A greater degree of local bladder discomfort was noted in those cases where the disease was known to be extensive, and this factor alone seems to be more important than the daily dose rate, provided there is no complicating infection. Despite a fairly aged group, survival was good with nearly three of four patients, 75% living for five years or longer. Late complications due to therapy are listed. (TCO)

**31958** RADIOTHERAPY IN THE TREATMENT OF PATIENTS WITH SEMINOMAS AND TERATOMAS OF THE TESTICLE. Smithers, D. W.; Wallace, E. N. K. (Royal Marsden Hospital, London). Brit. J. Urol., 34: 422-35 (1962).

A survey was made of a large series of patients who received irradiation for testicular neoplasms, with attention being given to effects of different types of radiation (conventional and supervoltage x rays), shielding of the healthy testis, measurement of doses in it and the surrounding radiation field, and minor and serious side-effects of radiation. In a series of nearly 200 patients with testicular tumors treated from 1930 to 1961, there were no cases of demonstrable renal damage resulting from irradiation, but the kidneys have never been directly irradiated during treatment. The fields of irradiation are applied routinely to the para-aortic nodes and to the pelvic nodes on the side involved. Film checks of field positions are taken in every case. The dose given to the protected testicle is measured. Such measurements were made on most of these patients treated, but even with precautions and added protection it has not been possible to reduce the dose to the remaining testicle to less than 50 rad in four to five weeks. The doses given are estimated at the lymph node levels and have varied slightly on either side of those prescribed according to individual circumstances, especially to the amount of distress due to anorexia, nausea, or diarrhea, or to the drop in the white blood-cell count. Radiation-induced symptoms have seldom been severe enough to warrant much reduction in prescribed dose since the introduction of supervoltage irradiation, but they do sometimes extend the time taken to give it. Patients with teratomas are at present given a lymph node dose of 4000 to 4500 rad in five to six weeks; those with seminomas have a dose of 3000 to 3500 rad in four to five weeks; the higher doses in the shorter times are preferred. Construction of a lead chamber for protecting the unaffected testis is described and illustrated. (TCO)

**31959** IONIZING RADIATIONS APPLIED TO PREGNANT WOMEN AT THE TIME OF RADIOLOGICAL EXAMINATION OF THE THORAX. de Rom, F.; de Backer, J.; Halkin, V. Bruxelles-Med., 44: 989-95(Sept. 27, 1964). (In French)

Fluoroscopy should never be used to examine the thorax of a pregnant woman. The secondary rays can be enough to cause lesions in the fetus, especially genetic lesions (sterility or mutations). The dose of ionizing radiations below which there is no danger to the fetus has not been established. During thoracic fluoroscopy, the patient receives 2000 to 15,000 mR per min. By contrast, radiography entails exposure of 40 to 100 mR. Radiography of the thorax can be recommended for pregnant women, provided it is done under proper conditions. The sensitivity of the fetus decreases with time, so it is preferable that radiographs be made after the third month of pregnancy. The pregnant woman must never be exposed repeatedly, as in radiophotography. The equipment for radiography must have sufficient voltage, give a filtered beam well defined by a tight diaphragm, very sensitive film, and a sensitive intensifying screen. Protection of the pelvis of a pregnant woman can be by chemical or mechanical means. Beta-mercaptoethyl amine has been utilized to protect the mother and fetus during radiological examinations, but this technique is still in the experimental stage. A sheet of lead has been used to cover the abdomen, but it cannot eliminate secondary rays. Radiography should not be repeated during the same pregnancy, except in the case of absolute necessity. (BBB)

**31960** A METHOD OF EVALUATING THE RADIOSENSITIVITY OF CANCEROUS CELLS. Baclesse, F.; Duplan, J.-F.; Royer, R. (Institut du Radium, Paris and Universite de Paris, Orsay, France). Bull. Assoc. Franc. Etude Cancer, 51: 395-406(July-Sept. 1964).

Fragments of the mammary radiocarcinoma T 1095 (from a mouse of strain XVII) were grafted on 60- to 70-day-old strain XVII mice. Fifteen to 18 days later, they were irradiated with none, 800, 1300, 2000, or 3000 R x ray. After four hr the mice were sacrificed and the non-necrotic part of the tumor minced and suspended

in Tyrode's solution. This cell suspension was injected into normal XVII mice of both sexes. Each animal received four injections in various parts of the body. The percentages of tumors in mice injected with tumors from control mice were as follows: $5 \times 10^3$ injected cells, 4%; $10^4$ cells, 40%; $5 \times 10^4$, 96%; and $10^5$, 98%. The percentages of tumors in mice injected with tumors of mice exposed to 800 R were, $5 \times 10^3$ and $10^4$ cells, 4%; $5 \times 10^4$, 78%; $10^5$, 92%. The percentages after injection of tumor cells from mice exposed to 1300 R were, $5 \times 10^3$ and $10^4$, zero; $5 \times 10^4$, 22%; $10^5$, 54%; $2.5 \times 10^5$, 82%; and $5 \times 10^5$, 100%. The percentages after injection of tumor cells from mice exposed to 2000 R were, $5 \times 10^3$ and 104, zero; $5 \times 10^4$, 2%; $10^5$, 20%; $2.5 \times 10^5$, 58%; and $5 \times 105$, 96%; and from mice exposed to 3000 R, they were, $10^5$, zero; $2.5 \times 10^5$, 2%; $5 \times 10^5$, 8%; and $10^6$, 26%. Mice were injected with various antimetabolites to determine their radiosensitizing effect. Results were expressed in the number of tumorous cells which had to be injected to cause tumors in 50% of the mice. In the controls, the results were, without x ray, $1.6 \times 10^4$ cells; after 1300 R, $8 \times 10^4$ cells. After 100 mg 5-fluorouracil (5-Fu) the number of cells necessary were, no x ray, $1.9 \times 10^4$; and after 1300 R two hr after injection, $2.1 \times 10^5$. The results with 0.5 mg actinomycin D were, no x ray, $2.1 \times 10^4$; and 1300 R 17 hr after injection, $2 \times 10^5$. With 0.1 mg N-mustard the results were, no x ray, $1.5 \times 10^4$; and 1300 R 2 hr after injection, $1.3 \times 10^5$. With 5.0 mg cyclophosphamide the results were, no x ray, $1.4 \times 10^4$; and 1300 R 2 hr after injection, $10^5$. The results with 1.5 mg amethopterin were, no x ray, $1.6 \times 10^4$; and 1300 R 2 hr after injection, $9 \times 10^4$. Following an injection of 5.0 mg mitomycin C, without x ray, the necessary number of cells was $3.0 \times 10^4$. No tumors appeared after 1300 R. 5-FU and actinomycin D were slightly radiosensitizing, while mitomycin C showed a strong sensitizing power. (BBB)

**31961** METABOLIC DISTURBANCES IN INOPERABLE CARCINOMAS AND THEIR TREATMENT WITH INHIBITORS. Rolle, J. (Chirurgische Abteilung des Ev. Krankenhauses Bethesda, Moenchengladbach, Ger.). Chirurg, 35: 1-3(Jan. 1964). (In German)

Uric acid and xanthoprotein values of patients with inoperable carcinomas were compared with those in normal individuals. There were no differences between the groups in uric acid, but the carcinoma patients showed a higher level of xanthoproteins. Some of the carcinoma patients were treated with the cytostatic agent Trasylol. This was administered by infusion over a 10 day period. The amounts of Trasylol given daily ranged from 10000 to 150000 units. Some of these patients also were x irradiated daily with from 130 to 840 R, with final total doses that ranged between 2500 to 2600 R. Uric acid, xanthoprotein values, leukocyte counts, and thrombocyte counts were used as symptoms of intoxication with Trasylol. In all cases studied the general condition of the patients improved within 4 to 5 days. The greater the amount of Trasylol given, the sooner the symptoms of elevated xanthoproteins disappeared. In all cases the xanthoprotein values decreased, and in a few cases the uric acid values also decreased. The leukocyte and thrombocyte values reached a constant value with the combined Trasylol and irradiation treatments. Trasylol may act as an enzyme inactivator or inhibitor, and thus reduce symptoms of irradiation syndrome. (BBB)

**31962** LONG-DEFERRED PATHOLOGICAL EFFECTS OF IONIZING RADIATIONS. Delpla, M. Concours Med., 85: 2501-21(Apr. 20, 1963). (In French)

Although very many publications have appeared on the subject, the late biological effects of radiation are only partially understood, and much more information is needed especially on effects of low doses. The existing evidence for carcinogenesis, leukemogenesis, life shortening, and mutational effects of sublethal doses of radiation is reviewed. Two cases are presented which illustrate these late pathologic effects. In the first case a radiologist had over a five-year period unknowingly exposed his feet during each radiologic examination because of a leak in the shielding below the x-ray tube. Twenty-six years after this exposure the first manifestations of chronic radiodermatitis developed on the right foot. The second observation concerns fracture of the femur, followed by bone sarcoma in a woman who many years before had been a Ra dial painter. At autopsy, a total of 15 $\mu$C of Ra could be detected in the body, mostly in the bone. The findings in these two cases are repeated many times by other observations, indicating without doubt that persistent low-dose irradiation can cause serious delayed effects. Evidence is reviewed relating to increased incidence of leukemia in Hiroshima and Nagasaki survivors and in patients irradiated for rheumatic diseases. A critical examination is made of data relating malignancy to in utero diagnostic irradiation and thymic therapeutic irradiation. Long-term occupational irradiation appears to have a life-shortening effect, and it is suggested that periodic hematologic examinations could detect such excessive exposure. The use of such examinations, and the exclusion of nonradiation effects on hematologic variables, is also considered. Some hematograms obtained from accidentally and therapeutically irradiated persons are illustrated to show the limits and usefulness of these parameters (total leukocyte, polymorphonuclear leukocyte, and lymphocyte counts in peripheral blood). An attempt is made to assess the relation between dose and genetic effects from experimental data, and of the genetic consequences of low-dose exposure to human populations. A linear, nonthreshold relation seems to exist in this respect, but the possibility of a sigmoid function with an intermediate linear segment appears to be equally acceptable in view of the evidence, or lack of it. The concept is offered that late neoplastic or genetic changes may be more frequent after repeated low doses than a single exposure of the same total magnitude. The inadequacy of legislation in France providing for indemnification of victims of prolonged occupational exposure is criticized. (BBB)

**31963** CLINICAL USE OF RADIOISOTOPES. Sklaroff, David M. (Albert Einstein Medical Center, Philadelphia). Current Therap. Res., 7: 206-8(Mar. 1965).

Some therapeutic applications of $^{198}$Au and $^{131}$I are considered, with emphasis on the possible hazards and observed complications resulting from the use of these radioisotopes. A new treatment for chronic synovial effusions in cases where orthodox methods had failed is described. This treatment was tried in 22 patients with persistent synovial effusions; 10 mC of colloidal radiogold was injected intra-articularly. This resulted almost always in relief of pain and increased movement of the joint, and no complications occurred as a result of the treatment. In patients followed from 10 months to six years there were only three failures. Results are also reported on the treatment of >2000 patients with hyperthyroidism with $^{131}$I. There was no increased incidence of leukemia or cancer of the thyroid gland in the treated cases and hypothyroidism was easily controlled with desiccated thyroid. Comparison of the risks and complications of anesthesia and surgery associated with thyroidectomy with $^{131}$I treatment indicated that, with the possible exception of children, radioiodine is the preferred treatment for all patients with Graves' disease or small nodular goiters with hyperthyroidism. Antithyroid drugs are a reliable means of controlling thyrotoxicosis, which is usually achieved in six to 12 weeks to avoid exposure to radiation, but there are two major drawbacks: the treatment requires careful supervision; and permanent control after a year or more is achieved in only one-half or two-thirds of the patients. The advantages of the radioiodine treatment are: simplicity, with minimal disturbance to patients' daily activity, and complications of surgery are avoided. This treatment is especially useful in the management of patients with heart disease and those who have had previous thyroid surgery. Surgery, on the other hand, is more rapid in its effect and also avoids radiation exposure of the gonads

and rest of the body. The question of which age range of patient with hyperthyroidism is best treated with radioiodine is discussed; and it was concluded that all patients with Graves' disease above the age of 25 may be treated with $^{131}I$, but this procedure should be combined with a full and careful follow-up of the patient for many years. Otherwise, surgery or antithyroid drug therapy should be used. The usual treatment dose of $^{131}I$ delivers 5 to 10 krad to the thyroid gland and 5 to 8 rad to the total body. There is a 7.5% incidence of hypothyroidism the first year, which increases 3% per year and reaches 26.5% by seven years. Other reports have noted an incidence of 2% in 10 years and a 6% incidence in 10 years after partial thyroidectomy. This study compared 251 patients treated by thyroidectomy with 925 patients treated with a dose of $^{131}I$ calculated to deliver 7000 rad to the thyroid gland. (TCO)

**31964** EFFECTS OF MATERNAL IRRADIATION ON THE EMBRYO AND FETUS. Spector, Roy. Develop. Med. Child Neurol., 5: 649-51(Dec. 1963).

The possibility that diagnostic x-ray investigations of the mother during pregnancy may damage the fetus in utero is discussed in relation to clinical practice, and experimental evidence relevant to this problem was examined. Mammalian development can be split into three stages: a preimplantation stage, an embryonal stage of organogenesis, and a fetal or growth stage. In man these correspond to 0.4 days; 4 days to 11 weeks; and 11-40 weeks. In the mouse ~80% of ova are destroyed by a dose of 200 R, but the survivors are normal. On the other hand, 5 to 35 R to mice in the pre-implantation stage increased the incidence of anencephaly in the survivors. In mice, fractionated irradiation in the first week of pregnancy can give rise to congenital malformations. In the offspring of mice irradiated in the embryonic period a raised incidence is seen of neonatal death and congenital abnormalities, mainly skeletal, with a low birth weight. There is a clear dose-effect relation, few abnormalities being seen after exposure to less than 25 R and a much increased incidence after 50 R. A similar level of radiation (35 R) is teratogenic in the mouse embryo. Several studies on the fetal stage of development show that large doses of irradiation are needed to kill the fetus. Fetuses that survive after being exposed to x rays late in pregnancy are often sterile. There is no evidence of a threshold teratogenic level of irradiation, which means that only in exceptional circumstances should pregnant women be exposed to x rays. Thus women of child-bearing age should undergo x-ray examination only in the 14 days following menstruation. (TCO)

**31965** USE OF Sr-85 IN STUDIES OF SKELETAL DISEASES. Kettunen, K.; Rekonen, A. Duodecim, 80: 909-14(1964).

External counting of $^{85}Sr$ is a supplementary diagnostic aid to x-ray examinations, and is especially adapted for the early diagnosis of bone metastases in mammary cancer. It may also be useful in early diagnosis of bone tuberculosis. The series studied included 13 patients with osteoarthritis of the hip or of the knee joint. The uptake of $^{85}Sr$ was higher in osteoarthritic than in normal joints. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31966** USE OF RADIOISOTOPES FOR SOLVING SOME KINETIC PROBLEMS IN MEDICAL RESEARCH. Kertesz, Laszlo (Medical Coll., Debrecen, Hungary). Fiz. Szemle, 15: 391(Dec. 1964). (In Hungarian)

Research initiated by Szalay at the University of Debrecen on the use of radioisotopes in medicine was continued at the Histological Laboratory and at the Institute of Experimental Physics. The studies were summarized in a review article on the distribution of radiobismuth colloids in the organism and their elimination. Later experiments aimed at the clarification of the toxicological problems of Pb and tracer studies of antigens. Special attention was turned to the development of instruments suitable for medical application. They made it possible to carry out metabolic experiments on the selective storage of radioactive I and Ca. Examination of the dynamic equilibrium of the I balance required special I derivatives, identifying the chromatographically separated radioactive I fractions by autoradiography and by other radiometric methods. The $^{132}I$ and $^{125}I$ were also used in the tests, in addition to $^{131}I$; use of this dual tracer technique made it possible to separate the processes in time and space. (TTT)

**31967** ON THE RELATION OF BONE MARROW FUNCTION TO SPLEEN IRRADIATION IN CHRONIC MYELOCYTIC LEUKOSIS. Schoen, D. (Universitat, Tubingen, Ger.). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 100: 254-6(Feb. 1964). (In German)

Four patients with chronic myelocytic leukemia were each alternately treated with Myleran and x irradiated with from 400 to 625 R, given in 17 to 21 days. The irradiations were administered homogenously to the spleen. Results of the treatments indicated that the spleen exerted a regulatory effect on the bone marrow function. The functional capacity of the marrow was indicated by normalization of the leukocyte and granulocyte concentrations in peripheral blood. The effect of splenic irradiation was to initiate what was apparently a regulative process that was limited in time, without correction of the basic bone marrow disorder. The effects observed were probably the result of an intensification of the process of maturation in the bone marrow. In view of the resumption of functional capacity of the bone marrow, homogenous irradiation of the spleen appears to be the most physiological form of treatment for chronic myelocytic leukemia. This treatment is preferable to any other that has effects to destroy cells. Eventually, the spleen will become refractory to irradiation because of the onset of fibrosis. (BBB)

**31968** RESULTS OF RADIOTHERAPY OF BENIGN AND MALIGNANT TUMORS OF THE NOSE AND THEIR TREATMENT PROSPECTS. Denecke, Hans Joachim. Fortschr. Kiefer-Gesichtschir., 8: 141-3(1962). (In German)

Irradiation of benign defects of the nose, such as cavernosa or naevi, usually give good results during early childhood, but defects of the skin and the nasal cartilage may develop in later years. Correction of these defects is difficult, but it can be done by skin and fatty tissue transplants from the upper arm area. In addition, the eyes may be damaged by excessive irradiation of the nose, producing ulcerations. Irradiation of malignant tumors often produces severe skin damage to areas near the base of the skull. Because of the irradiation damage produced the skin will not take transplants readily. However, in order to avoid meningitis it is imperative to seal the endocranium. Before doing this all evidence of carcinomatous growth must be resected before repairing the tissue defect, so that there will be no possibility of the carcinoma penetrating the dura. In elderly patients it is important to ensure that their circulatory status is constantly watched very closely so that the tissue implants will be successful. In order to avoid delayed irradiation lesions as much as possible the radiologist and surgeon must cooperate closely. Irradiation, especially in childhood should not exceed what is necessary. Careful preparation and protection of the cartilaginous tissue, followed by use of antibiotics and cortisone will produce rapid healing. (BBB)

**31969** HISTOPATHOLOGICAL STUDIES ON IRRADIATED LUNG TUMORS. Shimosato, Yukio (National Cancer Center Research Inst., Tokyo). Gann, 55: 521-35(Dec. 1964).

Histologic changes produced in 32 lung tumors by radiotherapy and clinicopathological correlations, with particular reference to the radiation dose, tumor size and types, and the time elapsed after completion of radiotherapy, are described. The process of healing and histologic structures revealing the biological effectiveness of irradiation are also described. Two forms of preoperative radiation were employed, $\gamma$ rays from a telecobalt unit and supervoltage x rays from a 6-Mev linear accelerator. Tumors were irradiated either through opposing anterior and posterior fields or by rotation to a total dose of 800 to 12,250 R in

5 or 6 treatments per week over 8 to 67 days, single daily doses varying from 100 to 300 R. One to 75 days (14 days in most instances) after completion of radiotherapy the tumors were resected. The relation between total dose and clinical effect indicated that to obtain a marked effect, more than 3500 R was necessary and the clinical effect varied markedly with a total dose of about 5000 R. No definite correlation between histologic types of the tumor and radiosensitivity was observed. Clinically, 10 cases showed a marked irradiation effect, 17 a moderate to slight effect, and 5 no effect. Histology of each group is described. These changes are summarized as follows: a decrease in the number of normal mitotic figures immediately after irradiation followed by an increase in the number of abnormal forms; initial nuclear and cytoplasmic swelling with prominent nucleoli, frequent concentration of the chromatin at the nuclear membrane, and appearance of multinucleated giant tumor cells; later cytolysis or an increase in eosinophilia of cytoplasm and karyolysis or hyperchromasia of nuclei; late appearance of bizarre tumor cells with homogenously and deeply eosinophilic cytoplasm with or without vacuoles and irregularly shaped, large hyperchromatic nuclei; ultimate lysis of tumor cells resulting in marked disruption of tumor patterns or local cure of the tumor. Along with disappearance of the tumor cells, histiocytic reaction with proliferation of fibroblasts is a prominent and important feature with fractional irradiation. Irradiated, shrunken tumors often presented a marked increase in elastic fibers, mostly due to the contraction of the tumor and pre-existing atelectasis around the tumor, resulting in an increased number of blood vessels per area. With the fractional irradiation employed here, radiation mostly affected the individual tumor cells, leading to their degeneration and ultimate death. Dead cells became autolyzed and disappeared, and cellular debris which could not be autolyzed caused histiocytic reaction and granulation tissue. Coagulation necrosis of the center of the tumor nests was not due to the direct effect of radiation, since it also occurred in nonirradiated tumors. This type of necrosis is due to the lack of oxygen and nutrients. To sterilize most of the tumor cells of lung cancers of a moderate size, it is apparent from these results that at least 6000 to 7000 R is necessary. The radiation dose required is increased with the increasing size of tumors. The presence of almost unaltered tumor cell nests adjacent to markedly damaged cell nests, and the presence of cell nests consisting of a mixture of unaltered and markedly altered cells were frequent findings in irradiated tumors, indicating the different radioresponsiveness of the tumor cells in a tumor and cannot be fully explained by environmental factors alone. (BBB)

**31970** CLINICOPATHOLOGIC ASPECTS OF ACTINIC ENTERITIS. Schier, Johannes; Symmonds, Richard E.; Dahlin, David C. (Mayo Clinic and Foundation, Rochester, Minn.). Gynecol. Obstet., 119: 1019-25(Nov. 1964).

Of 34 patients described with radioenteritis severe enough to require surgical intervention, only 1 was a male. He had received radiation treatment for abdominal metastasis after orchiectomy for seminoma. Of the 33 women, 20 were treated with radiation for carcinoma of the cervix, 6 for adenocarcinoma of the uterus, 2 for cystadenocarcinoma of the ovary, 2 for menorrhagia, and 1 each for uterine fibroids, undetermined pelvic carcinoma, and undetermined rectal tumor. Diarrhea, nausea, and generalized abdominal distress, during or immediately after radiation therapy, were common, but these symptoms generally subsided shortly after termination of the irradiation. After a symptom-free interval of several months or years, evidence of the delayed actinic reaction became manifest. The symptoms, in order of decreasing frequency, were abdominal pain, vomiting, alternate presence of constipation and diarrhea, and rectal bleeding. As a result of the experience with 31 of the 34 patients in this series, primary resection with end-to-end anastomosis seems to be the preferable procedure and should be carried out whenever possible. If it is impossible to free the injured intestine sufficiently, a sidetracking procedure may be justified. Wide resection, well beyond the gross margins of radiation changes, is of the utmost importance. All anastomoses must be made between normal-appearing loops of intestine, since the intestine damage by radiation will heal poorly. (TCO)

**31971** CANCER ARISING MANY YEARS AFTER RADIATION THERAPY: INCIDENCE AFTER IRRADIATION OF BENIGN LESIONS IN THE NECK. Hanford, John M.; Quimby, Edith H.; Frantz, Virginia Kneeland (Columbia Univ., New York). J. Am. Med. Assoc., 181: 404-10(Aug. 4, 1962).

A survey was made of 458 patients who had been irradiated for nonmalignant diseases in the region of the thyroid gland, at the Presbyterian Hospital between 1920 and 1950, to determine the incidence of thyroid cancer in thyroid glands incidentally or deliberately irradiated. The three main groups of patients were those treated for enlarged thymus, toxic goiter, and tuberculous adenitis. The first two groups showed no significant increase in thyroid cancer, or in all cancer, above statistical expectation; although the thymus group was probably too small to warrant conclusions. However, in the group with tuberculous adenitis, in addition to the expected incidence of all cancer, seven cases of thyroid cancer appeared. These cancers were found at operation 10 to 27 yr after the irradiation. However, only one cancer in this group appeared in an individual under 20 yr of age; all other patients were more than 25. The x rays employed in the treatments were of low voltage (100 or 130 kv) with a 2 or 3 mm Al filter. The estimated doses to the thyroid gland were not large. Five of 54 patients who received doses of between 500 and 1000 R developed thyroid cancer, while thyroid cancer appeared in only two of 66 who received 1000 R or more. There is, therefore, a suggestion that smaller doses, in this disease, may be somewhat more influential in predisposing to cancer than are large ones. In a smaller group of nonirradiated tuberculous adenitis cases, no thyroid cancers were found. It thus appears that the disease itself is probably not responsible for the development of cancer, but that small doses of radiation to the gland may sometimes act as at least a part of the provocation. (BBB)

**31972** PREVENTION OF LIVER METASTASES BY INTRAVENOUS RADIOISOTOPES: USE OF $^{32}$P-LABELED COLLOIDAL CHROMIC PHOSPHATE IN RATS. Ackerman, Norma B.; McFee, Arthur S.; Loken, Merle K. (Univ. of Minnesota, Minneapolis). J. Am. Assoc., 187: 826-8(Mar. 14, 1964).

The effect of this agent as a means of preventing liver metastases was studied in rats following the injection of tumor cells in the portal vein. In addition to the injection of tumor (Novikoff hepatoma) cells, the animals received an intravenous administration of $^{32}$P-tagged colloidal chromic phosphate in a therapeutic dose to the liver of 75 $\mu$C. In the control group, 75% of the rats had tumors in the liver at two weeks. This decreased to 31%, or eight of 26 animals, in the group receiving colloidal chromic phosphate one min after the tumor cells. Of the 60-min colloidal-chromic-phosphate group 38%, or ten of 26 animals, had liver tumors in two weeks, and the 24-hr colloidal-chromic-phosphate animals 42%, 11 of 26, had liver tumors. Tumor take in animals pretreated with colloidal chromic phosphate was not significantly different from that in the control group. Approximately 80% to 90% of this material is concentrated by the liver. Only 2% to 15% is taken up by the spleen and the remainder of the chromic phosphate is distributed in very small quantities among the other tissues of the body. It is cleared from the blood within minutes. There is no problem of bone-marrow depression following injection of this material. With massive experimental doses in animals, liver necrosis occurred, but the doses were considerably higher (from 50 to 100 times) than those used here. It was calculated that a dose of 3000 rad was delivered to the livers of the rats used after administration of 75 $\mu$C of chromic phosphate. This dose was felt to be in the low therapeutic

range. The radiotherapy is, in part, effective because of the almost ideal geometry involved, that is, radiation directed against single cells or small aggregates of unrooted cells. The reduction of liver metastases by more than one-half after use of intravenous $^{32}P$ observed here may be of clinical significance. (BBB)

**31973** BRAIN SCANS IN DIAGNOSIS OF BRAIN TUMORS: SCANNING WITH CHLORMERODRIN Hg-203 AND CHLORMERODRIN Hg-197. Bucy, Paul C.; Ciric, Ivan S. (Northwestern Univ., Chicago). J. Am. Med. Assoc., 191: 437-43(Feb. 8, 1965).

The use of radiomercury brain scanning for detection of intracranial lesions in >900 patients is described. The risk involved in the use (even repeated use) of radioactive mercurial diuretics in this manner is believed to be inconsequential. In 1964 the material used was changed from $^{203}Hg$ to chlormerodrin-$^{197}Hg$, greatly reducing the exposure of the patient's kidney to radiation. The present equipment is less expensive and the total expense to the patient in view of its great diagnostic value is relatively small when compared to other diagnostic procedures. This test has proved to be the most important single procedure for the diagnosis of a brain tumor. It does not demonstrate all tumors, and it demonstrates lesions other than neoplasms, particularly granulomas. In 80 cases of brain tumors, 61 were localized by radiomercury brain scans. The scan remained entirely normal in 11 cases, while it was classified as equivocal in eight cases of brain tumors. All of the brain tumors but one (probably a metastatic tumor with multiple areas of localized increase in radioisotope concentration) were verified at operation or histologically or both. The greatest incidence of positive and localizing scans was found in cases with supratentorial tumors. Of 66 patients with a supratentorial tumor in whom 88 scans were made, 54 tumors were accurately localized. Glioblastomas and meningiomas gave the highest incidence of satisfactory results and the method is useful with many other tumors, but a few, such as epidermoid cysts, gave negative results. Lesions other than tumors, granulomas, angiomas, and cerebral infarcts may also give positive results and must be differentiated from tumors by other means. The method is relatively simple, painless, and associated with little or no risk. Selected cases are described which demonstrate the great diagnostic advance accomplished by the introduction of examination of the brain using a radiomercury compound. (TCO)

**31974** COBALT-60 IRRADIATION FOR ADVANCED CARCINOMA OF THE PALATINE TONSIL. Brizel, Herbert E.; Scott, Ralph M. (Univ. of Louisville, Ky.). J. Am. Med. Assoc., 192: 723-5(May 24, 1965).

Treatment of 19 cases with $^{60}Co$ $\gamma$ radiation is described, along with complications attributable to radiation and observations on advantages of $^{60}Co$ over other types of radiation. All patients were treated with $^{60}Co$ $\gamma$ rays without supplementary radium needle implants. Adequate margins were irradiated around the estimated tumor to include all of the primary, adjacent spread, and metastatic nodes. Usually bilateral, symmetrical, evenly exposed portals were employed, but in a few instances a unilateral portal was used. The average portal dimension was 60 $cm^2$ with a typical field of 7 × 9 cm. Tumor doses were ~6000 R in six weeks. Ten of 19 patients had a two-year or greater tumor-free survival (53%), and seven of 15 were tumor free for three years or more (47%). Eight of nine treatment failures had persistent or recurrent disease evident within one year of the onset of irradiation. Survival was directly related to the total extent of disease. There was a 70% (seven of ten) two-year survival in the 1B and 2A stages, and only a 30% (three of nine) two-year survival in the 2B stages. Six of the 13 patients present with adenopathy were tumor free for two years or more. An epithelitis of the pharynx was universally present at the completion of treatment. This was transient and offered no difficulty in management. Skin reactions amounted only to a dry epidermis and left no permanent changes. Dryness of the mouth and loss of the sense of taste were experienced by almost all patients. In most cases these functions slowly returned to normal after varying periods of weeks or months. Advantages of $^{60}Co$ irradiation are discussed. (TCO)

**31975** THE EFFECTS OF RADIOTHERAPY ON ORAL TISSUES. Rosenthal, Lester E.; Wilkie, Bernard (Albert Einstein Coll., Bronx, N. Y.). J. Prosthetic Dentistry, 15: 153-6(Jan.-Feb. 1965).

Some problems encountered in irradiation of oral cancer are considered, with emphasis on some ways of preventing serious injury to healthy oral tissues. The main problems dentists are concerned with in radiotherapy are: (1) decay of teeth, (2) osteoradionecrosis, (3) mucositis, and (4) moniliasis. The question of the removal of teeth prior to radiotherapy is controversial; some dentists suggest the removal of only decayed teeth and teeth in the path of the x-ray beam, while others believe in the removal of all teeth. It is suggested that progressive caries that develop postirradiation in what previously were caries-free teeth are due to factors other than those produced by the direct x-ray beam. The changes in saliva, from the radiation effects on the salivary glands, probably are the predisposing factor to this type of dental caries. The parotid gland is most affected by radiation. This gland secretes the serous component of saliva, and when radiation removes the serous component, the consistency of the saliva becomes more mucinous, which may result in rampant caries. The areas of the tooth first affected are those where the enamel is the thinnest, such as the cervical areas and the incisal edges. The removal of decayed teeth with involved pulps after radiation therapy may lead to another complication, osteoradionecrosis. For development of osteoradionecrosis, three factors must be present: radiation, trauma, and infection. The removal of infected teeth from irradiated bone may supply these factors. Teeth should not be removed from jaws that have received over 3500 R if it can be avoided. If extraction is absolutely necessary, it should be done with as little trauma as possible and with broad spectrum antibiotic coverage. Complete dentures should not be constructed for patients who have received radiotherapy in or about the oral cavity where the jaws receive radiation. Even the best denture abrades the oral mucosa to some extent. Erythema and ulceration of the mucosa from denture irradiation may lead to osteoradionecrosis of the boné beneath the denture. Necrosis can occur two or three months following therapy or any time thereafter. Mucositis usually occurs after 2000-R is administered to the oral tissues and usually disappears at the 5000-R level. It may persist for a few weeks after the completion of therapy. A less frequent postirradiation complication is wide-spread moniliasis infection, and if not brought under control, it can be fatal. (BBB)

**31976** EFFECT OF X-RAY THERAPY ON PATIENTS WITH PEYRONIE'S DISEASE. Duggan, H. E. (Univ. of Alberta Hospital, Edmonton). J. Urol., 91: 572-3(May 1964).

The effects of radiation, doses used, testes shielding, and cure rate in the treatment of Peyronie's disease, or plastic induration of the penis, are described in 87 patients. It was thought that x-ray therapy had some advantage over radium in that there would be a more homogeneous dose of irradiation throughout the penis, and that the results might also be improved by more prolonged fractionation of the treatment. Two levels of 270-kv x-radiation dosage were used. One group was given 1000 R to the skin using right and left lateral ports and the other group 800 R to the skin using similar ports. One port was treated daily using 200 R with backscatter and the total dose to each port continued to 800 or 1000 R. The over-all time was 10 to 12 days. A lead shield was placed over the testicles. This shield, together with the fact that the x-ray beam was tangential across the testicles, permitted very little radiation to reach the gonads. Ten patients were given a second course of therapy with the same x-ray factors. However, the dose was reduced to 400 R with backscatter to one port and 600 R to the other port in a total of five days. The average time before any improvement took

place was six months and varied between one and 18 months. Patients who received the higher dose of radiation did better than those receiving the lower dose. In the former, 83% were either symptom-free or improved and in the latter, 71%. Ten patients given a second, shorter course of therapy had shown no response to the first course. A third course of therapy was given in only one case. It is suggested that no case be given a second course of x-ray therapy until at least 12 months have elapsed following the first course. Only in exceptional circumstances should a third course of x-ray therapy be considered. It is concluded that x-ray therapy for plastic induration of the penis gives better results than many other forms of treatment. (BBB)

**31977** CONSEQUENCES OF PRENATAL RADIOGRAPHY. Lancet, 1: 1204(May 30, 1964).

Some surveys made in the United Kingdom on the possible hazards of in utero exposure during radiodiagnosis are reviewed, and, in particular, a Council Committee on Protection against Ionizing Radiations whose aim is to examine the available data and make assessments where possible. Surveys conducted in 1956 and 1958 showed that routine prenatal radiography could increase the normal incidence of childhood leukemia, and other malignancies, with a peak incidence in the early years. However, the Forum questioned these surveys at two important points: (1) was there a selective bias in a mother's memory, the mother of a dead child remembering things more carefully than the mother of a living child; and (2) was there bias among the choice of controls since the first choice for a control was not always used? Both of these possible sources of bias were avoided in a later survey published in 1962. The evidence from these two surveys now suggests very strongly that obstetric radiography can lead to some increases in the incidence of childhood malignancy. The best estimate of risk was a 40% increase above the normal incidence of childhood malignancy (with confidence limits ranging from about 20% to 64%); this corresponds to an excess incidence during the first ten years of life of one case of childhood malignancy per 2500 fetuses exposed. None of the individual surveys (11 have been published so far) differed from this estimate of risk in a statistically significant way. In one large study the apparent absence of radiation effect was statistically compatible with a real risk of ~40% above normal incidence. It has not been possible to determine the dose received by individual children, and only average doses can be ascertained. One survey indicated the fetal gonad dose averages 1 R but may range from 30 to 10,000 mR. In earlier years the dose must have been higher. There is some indication of an increase of incidence with the number of x-ray films used, but the dose data are too uncertain to allow conclusions about the dose-response relation. A further complication is that radiographs were taken at different stages of pregnancy, when radiosensitivities are not the same. The available data for exposure during the first and second trimesters are very scanty, but it was considered unlikely that the risk during these periods was higher than twice the risk for the third trimester. The sensitive period for induction of malignancy need not be the same as for other effects of radiation on the fetus; the 7th and 8th months, when the bone marrow begins to develop its hematopoietic function, may prove to be the most sensitive time. From estimates of leukemogenic risk in the adult survivors at Hiroshima and Nagasaki, and of patients after radiotherapy for ankylosing spondylitis, it appears that the fetus is more sensitive than the adult to the leukemogenic effect of radiation. In applying these conclusions on the carcinogenic effect of prenatal x rays to other situations, it must be considered that there is no evidence about the comparative risk of acute and protracted exposure. At present, in calculations of risk, the time over which the dose is delivered cannot be taken into account though it is possible that protraction of the exposure will reduce the effectiveness of radiation in producing leukemia and other malignancies. (BBB)

**31978** CHRONIC BRONCHITIS AND RADIOTHERAPY OF THE LUNG. Brewin, T. B. (Royal Infirmary, Glasgow). Lancet, I: 1443(June 27, 1964).

Criticisms are advanced to the concept that chronic bronchitis does not render a patient with carcinoma of the bronchus more liable to lung fibrosis after radiotherapy. This is in reply to an earlier publication which concluded that patients should not be denied treatment, nor should the planned dose be reduced, because they also have chronic bronchitis. It was not mentioned how much lung should be exposed to radiation—a problem that is inevitably related to the problem of how much lung fibrosis the severe chronic bronchitic can tolerate. Since the radiotherapist cannot determine exactly how far the malignant process has spread, a balance has to be struck between the advantage of including all possible lines of local spread and the disadvantage of exposing a patient to the risk of more-lung fibrosis than he can be expected to tolerate. The earlier report stated that there was no significant difference between any of the groups (i.e., the non-bronchitic, the mild bronchitic, and the severe bronchitic) in the average dose, or in the average dose per treatment, or in the length of the course of treatment. Possibly there was a difference in the amount of lung that was subjected to radiation. Whether or not lung carcinoma patients with gross chronic bronchitis are more liable to develop lung fibrous after radiotherapy, their ability to tolerate it would probably be impaired. The smaller the patient's respiratory reserve, the nearer he is to permanent and disabling shortness of breath, should radiation fibrosis occur and still further reduce (as it must) the amount of available functioning lung. The patient who suffers more radiation lung fibrosis than he can tolerate is in much the same state as the patient who has more lung resected by thoracic surgery than he can tolerate. The treatment may have done him more harm than good. It is concluded that it would be unfortunate if the impression was given that severe lung fibrosis can be as well tolerated by the severe bronchitic as by the patient with good lung function, or that there is no need for the radiotherapist to even consider this point when deciding how much lung to irradiate. (BBB)

**31979** CHRONIC BRONCHITIS AND RADIOTHERAPY OF THE LUNG. Gillam, P. M. S.; Heaf, P. J. D.; Hoffbrand, B. I.; Hilton, Gwen (University Coll. Hospital, London). Lancet, 1: 1443-4(June 27, 1964).

A reply is made to the criticisms of Brewin that patients with chronic bronchitis are not more susceptible to radioinduced lung fibrosis. This criticism was raised to the authors' earlier publication (Gilliam, Lancet, 1: 1245(1964)) which indicated that bronchitis patients were not more liable to suffer radiation changes. Although it is the authors' policy to avoid irradiating lung free of tumor, it is difficult to measure accurately how much lung is subjected to radiation, because of individual differences in chest shape, volume of mediastinum, and volume of tumor. However, if such differences can be ignored in groups of the size studied, it is reasonable to assume that the volume of lung irradiated is related to the skin area through which the radiotherapy is given. The lung volume will be small with mediastinal fields and greater with lateral and oblique ones. An accompanying table shows the mean skin area and the mean skin dose that was delivered to (1) mediastinal, lateral, and oblique fields. It shows that there was no relation between the lung volume irradiated, the dose to lung, and the presence or absence of bronchitis. As regards radiation fibrosis, it is reasonable to assume that an equal amount of fibrosis will be more disabling to a bronchitic patient than to one without bronchitis; however, there was no information on this point as none of the previously described patients were severely disabled by fibrosis. It is reiterated that no clinical or functional evidence was found that bronchitis rendered patients more liable to radiation changes. (BBB)

**31980** COMBINED THERAPY IN MALIGNANT DISEASE. Lancet, 2: 797-9(Oct. 10, 1964).

Attempts are made to resolve some of the conflicting evidence relating to the synergistic action of radiation when combined with chemotherapy in the treatment of malignant diseases. It is pointed out that expressions like enhancement, potentiation, and sensitization are freely used in discussing combined radiation and chemotherapy, but their meaning is not always defined. If not, for example, a dose of 3000 rad is combined with an antimitotic drug and the effect is found to be consistently better than when the same dose of radiation is given without the drug, this is not necessarily evidence that the drug has potentiated the effect of the radiation, or that it possesses the property of increasing the radiosensitivity of tumors. It may have been just as effective (perhaps more effective), safer, easier, or more comfortable for the patient, if 5000 rad had been given without any drug. If this second method of treatment had been adopted, it could not be said that the first 2000 rad of radiation had potentiated the effect of the other 3000 rad; the effect is purely additive. It must be determined whether the action of combined therapy is only additive, or is truely synergistic. Even if synergism has been convincingly demonstrated in the lab, there is no benefit to the patient unless there has been a change in the differential between the response of normal cells and that of malignant cells. Combined therapy offers no real progress unless it produces the same effect on the tumor with less unwanted actions. Thus, if the synergistic effect is as great in normal cells as in malignant cells, nothing of value has been achieved. It is surprising therefore that discovery of increased radiation reactions in the skin after the administration of actinomycin D, for example, was reported as a hopeful sign of its therapeutic possibilities. Reported excellent initial responses in malignant disease of various kinds, including lung cancer, when intravenous 5-fluorouracil was combined with radiotherapy in an earlier series, mostly of a few cases and without adequate controls, have not been fully realized later. More recently, another group, using the same drug, reported that toxic reactions were common and, although there were a few excellent responses, the general picture was not encouraging. Other workers indicate that the response to combined treatment is often more rapid than to radiation alone, but whether the benefit is sufficiently lasting to justify the added discomforts and possible dangers has not been decided. In a large controlled trial by four cooperating hospitals, addition of nitrogen mustard to radiotherapy appeared to increase toxicity, without improving survival, and without contributing enough positive effects to warrant the extra labor and toxicity. Chlorambucil and thioTEPA have been effectively used with radiation in the treatment of disseminated malignant disease of the ovary, but like all the drugs mentioned, these two may depress the bone marrow and therefore must be controlled with special care when they are given with radiation. Patients on the combined therapy may have more infections than those receiving radiation alone, and show a greater tendency to lose weight. (BBB)

**31981** SCANNING THE KIDNEY. Lancet, 2: 1281-2 (Dec. 12, 1964).

American reports on the use of radioisotope scanning in the investigation of renal disease are frequent, but the method has been little applied as yet in Europe. It has an advantage over the much-used radioactive renogram in that it can yield information about segmental function of the kidney, whereas the renogram deals with the entire organ. Scanning is simple and safe, and can be carried out on either inpatients or outpatients. Radioactive material which is specifically concentrated by the normal tissue of the kidneys is given intravenously, and one or two hr later the patient is scanned by a scintillation counter which systematically traverses the lumbar region. Although $^{131}$I-labeled Diodone and Hippuran were used first, they were soon abandoned because of rapid excretion by the kidneys, and more recently, $^{203}$Hg-chlormerodrin has been used with more satisfactory results. It is rapidly and specifically taken up by the renal cortex, fixed in the tubular cells, and excreted in the urine. The retention of $^{203}$Hg by the renal tubule cells enables the renal outlines to be traced by the external counter. In uremic patients increased activity on the right side due to the liver may be misinterpreted as an enlarged right kidney. The great value of the technique is its ability to demonstrate parenchymal lesions; infarcts, areas of ischemia, and occlusion of the renal artery can be identified; and space-occupying lesions are well displayed, a tumor as small as 2 cm being detectable. Scanning is also useful in the investigation of obstructive lesions: when there is evidence of functioning tissue on the scan, the obstruction is of recent origin, and restoration of function can be expected after removal of the block. The dose of radiation to the kidney is small. Although 100 to 150 $\mu$C of $^{203}$Hg are given, with a physical half-life of 45 days, the effective half-life within the body is short, averaging three hr, and the radiation dose to the kidney is less than 0.5 rad. Recently, $^{197}$Hg, with a half-life of 65 hr, was used to label chlormerodrin, and this reduces radiation dose still further. (BBB)

**31982** RADIOLOGICAL HAZARDS TO PATIENTS. Lancet, 2: 1325-6(Dec. 19, 1964).

Recent surveys of radiation exposure levels of patients undergoing radiodiagnostic procedures in the United Kingdom are briefly reviewed. The earliest estimate, in 1956, gave a figure for exposure in diagnostic radiology as equivalent to at least 22% of natural background radiation. The total estimate for all the other contributions, including occupational exposure and radioactive fallout, amounted to only a further 4.8%. As the mean gonad dose from natural background radiation was estimated to be about 100 mrad per person per yr, the two doses as percentages would be numerically the same expressed in mrad per person per yr. The main findings of the 1960 report of the Adrian Committee, the most important of which was the result of the genetic dose survey, indicated a much lower exposure than was expected. In fact, the population genetic dose from diagnostic radiology was found to be only about two thirds the previous figure and even when the contribution from radiotherapy was added, the total dose of 19.3 mrad per person per yr was still less than the min previously estimated for diagnostic radiology alone. Nevertheless, the Committee reported that, in many instances of diagnostic and therapeutic procedures, the dose could be substantially reduced without any detriment to the efficiency of the examination or treatment. The report indicated that, if its recommendations were carried out, the total annual genetic dose to the population from all forms of medical radiology could be reduced to 6 mrad per person per yr or less, of which the diagnostic contribution need be only 2 mrad. Four years since this report was published, the Protection Committee of the British Institute of Radiology has considered the extent to which the recommendations have been implemented. In some hospital diagnostic departments, probably all the technical recommendations have been put into effect, whereas in others they have not. The Protection Committee has recently prepared a memorandum containing some general comments on the Adrian report, together with summaries of the major recommendations of the Adrian Committee and its clinical panels. Its aim is to redraw the attention of radiologists to the recommendations of the Adrian Committee. To learn how effective the implementation of the recommendations has been, an investigation of diagnostic radiology in the Sheffield hospital region has been undertaken. A report of the first results of this survey show that all the recommendations are not being observed and that much more effort is required to ensure that radiological safety measures in hospitals are enforced. (BBB)

**31983** FIRST RESULTS OF STUDIES ON OSTEOPATHIES WITH RADIOACTIVE CALCIUM. Pansu, D.; Bizollon, M. C.; Chapuy, M.-C.; Bolot, F.; Vignon, M. G. (Hopital des Charpennes, Villeurbanne, France). Lyon Med., 212: 307-17(1964).

The study of calcium metabolism using radioactive tracers has several technical difficulties. Determinations are delicate and difficult, and practical problems arise

since for complete information, determinations should be made of the intake and output of calcium and repeated blood samples are necessary for determination of the radioactivity curve in the blood. Interpretation of the findings is still a point of discussion, but the preliminary results confirm that this method is valuable for studies on the calcium metabolism. The method permits a precise diagnosis of atypical osteopathies without changes in the blood: normocalcaemic tetany, purely osteoporotic hyperparathyroidism, and osteoporosis from calcium deficiency. Information is also obtained on the pathogenic mechanisms of new metabolic osteopathies: tubulopathies, glomerulopathies, malabsorption, and idiopathic hypercalciuria. First results show that in senile osteoporosis there is a reduction of the calcium pool and osseous exchange; in treated osteomalacia there is an acceleration of turnover with acceleration of bone fixation and an increased pool. In postmenopausal osteoporosis the calcium pool is normal and storage is reduced. Further studies are necessary to confirm these results. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**31984** TUMORS DEVELOPING AFTER RADIATION TREATMENT OF BENIGN TUMORS. Vandor, Ferenc; Ravasz, Laszlo (Fovarosi Onkoradiologiai Intezet, Budapest). Magy Radiol., 17: 8-12(Feb. 1965). (In Hungarian)

The development of malignancies is described in nine patients who had received irradiation treatment for benign conditions decades earlier. The conditions treated 10 to 43 yr earlier included eczema, sycosis barbae, hypertrichosis, tuberculous coxitis, and lymphoma. Six patients developed carcinoma of the skin, two of the larynx, and one case of bone sarcoma was found. In most cases the doses administered could not be determined due to time lapse, but in some cases the doses amounted to 2000-R fractional radiation and in one case 3500-R fractional deep irradiation treatment for lymphoma had been given. It could not be assumed in these cases that the x-ray treatments themselves were causative of the later malignancies, but the unnecessary use of them and the inadequate protective methods then available are mentioned. Even with the methods available today it is recommended that benign skin disorders not be treated with radiation. Such treatments for tuberculosis, hypertrichosis, and sycosis barbae are contraindicated. Advisability of radiation treatment of any benign condition should be carefully weighed, and if it is indicated the treatment should be limited to the least possible dose, and administered under most careful supervision. The occurrence of radiogenic tumors is a rarity. (BBB)

**31985** INDICATIONS FOR X-RAY EXAMINATION IN CHILDHOOD. Koeteles, Gyoergy; Kemeny, Pal (Madarasz Utcai Csecsemo- es Gyermekkorhaz, Budapest). Magy. Radiol., 17: 34-6(Feb. 1965). (In Hungarian)

Consideration is given to the need to reduce the number of x-ray examinations of children in order to reduce genetic damage. A survey made of the number of cases referred to the hospital for x-ray examinations revealed that fully two-thirds of the recommended examinations were unnecessary. After thoroughly reviewing all requests for gastrointestinal examinations over a period of three years, in the years 1962-63 a further reduction in x-ray diagnostic exposure was achieved. It is recommended that children requiring gastrointestinal x-ray examination should be hospitalized for conduction of other tests and examinations before being submitted to fluoroscopy. Outpatient fluoroscopic examinations should be avoided in children. The number of fluoroscopic examinations formerly constituted 40 to 45% of all radiological examinations; however, this figure has now been reduced to 2.5% of all examinations and it is expected that further reduction can be achieved. Pyelographic examinations have been increasing and in 1963 showed an increase of 62% over 1958. However, this increase seems well founded as positive results were obtained in 53.8% of the cases examined. To further decrease the number of x-ray examinations in this hospital, it is necessary that the pediatrician perform thorough periodic physical examinations of children rather than depend on x-ray diagnosis to detect incipient disorders. It was the general experience that pediatricians not dependent on x-ray diagnosis perform more adequate examinations. This point should be stressed in the training of physicians at the medical school level. In recuperating cases of pulmonary disease, x-ray examinations should not be performed on patients considered clinically healed. (BBB)

**31986** EXAMINATION OF THE ALTERATION OF THE SERUM PROTEIN FRACTIONS IN WOMEN WITH CANCER DURING RADIATION TREATMENT. Kolya, Zoltan; Csoemoer, Sandor; Szeker, Janos (Orvostudomanyi Egyetem I. sz. Noi Klinika, Budapest). Magy Radiol., 17: 103-6(Apr. 1965). (In Hungarian)

Data were collected on the alteration of serum protein fractions in 33 cases of cancer, 20 of whom received only x radiation and/or Ra treatment as their condition was inoperable. Tests were conducted by a modified paper electrophoresis method. Results indicate that the typical, if not specific, alterations in serum protein generally found in the cancer patient are further altered by radiation treatment in parallel with increasing doses. The albumin values decreased; at the same time the globulin values, particularly that of $\alpha_1$-, $\alpha_2$-, and $\gamma$-globulin increased. Comparison was made between the postoperative and inoperable patients and their serum protein reactions to radiation. It was found that the protein fraction changes were more pronounced in the inoperable patients, thus further indicating that the dysproteinemia due to the progression of the cancer was augmented by radiation treatment. It is recommended that protein intake of the irradiated patient be increased either through the diet or parenterally. (BBB)

**31987** THE HUMANE ATOM: RADIOISOTOPES AT THE SERVICE OF MEDICINE. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Med. Ann. District Columbia, 33: 595-9(Dec. 1964).

Some new instrumentation and techniques are discussed before considering radioisotopes and their applications. Radioisotope scanners and cameras have become very versatile instruments. The early dot scanner was used most in thyroid studies because the organ lies close to the skin and scattering of radiation was minimized. Pulse-height selection and the use of focusing collimators in later scanners made it possible to apply scanning techniques to the deeper-lying organs. In the photoscanner, a mechanical tapper bar records counts from the scintillation counters by placing dots on a piece of paper, replacing by recording with light on photographic film. Another useful instrument is a different version of the $\gamma$-ray scanner known as the positron scanner. With the annihilation of a positron by a negative electron, two $\gamma$ rays of equal energy are released in exactly opposite directions, and scintillation counters counting in coincidence placed on opposite sides of the patient's body can detect a positron-emitting radioisotope and locate it on a straight line between them. A very clear picture is obtained with this scanner. Equally useful improvements have been made in recording on film with scanner cameras. Earlier types were slow because of the deliberate back and forth motion of the detector over the patient. Now there are scintillation cameras which operate from a fixed position and greatly reduce the time required for analyzing the isotope distribution and consequently the length of time the patient must be immobilized. With these faster cameras, it is possible to follow the progress of radioisotopes into and out of organs to obtain information on disturbances in organ functions before gross pathologic changes have occurred. There have also been improvements in methods of displaying scanner data, such as multicolor printout systems which show the radioisotope distribution in the form of color contour maps. One of the most promising new instruments is the whole-body counter. It may prove to be very useful in medical diagnosis and research. There are more than 70 whole-body counters in operation, and about 40 of these are in the United States. Since it is im-

portant to keep radiation exposure especially low in radioisotope studies on infants and small children, whole-body counters find an application in thyroid conditions in children. With a Geiger counter, 50 to 100 μC of $^{131}I$ was administered for a determination of thyroid uptake. Now the dosage can be as small as 0.1 μC. In addition to a review of the development of radioisotope instrumentation, the increase in the availability and uses of artificial radioisotopes is discussed. With the successful development of nuclear reactors it is possible to realize the great potential of radioisotopes. Before the reactor, smaller quantities were created in cyclotron bombardment, but once the reactors began to operate, large quantities of hundreds of radioisotopes were produced and powerful new sources could be developed to extend the range of radiation therapy. Chiefly because of the reactor, radioisotopes are now used for medical diagnosis and treatment in over 2000 hospitals and medical groups. About 30 different radioisotopes are used in research, or for diagnostic purposes, and a half-dozen are applied in treatment. Applications of individual isotopes of C, S, O, Co, Fe, I, P, Hg, Au, and Tc in medical diagnosis and treatment are described. (BBB)

**31988** CHRONIC LEG ULCER. Sborov, A. M. Minn. Med., 47: 419-21(Apr. 1964).

The presence of a radioinduced ulcer and development of skin cancer 10 to 20 years after radiotherapy for a benign condition are described. This 74-year-old-woman had an ulcer on the lateral aspect of the left ankle which had been present for three years and developed without incident or trauma. Three years earlier four biopsies were taken from the ulcer, and these were reported as showing only ulcerated and chronically infected tissue. Several months of hospital treatment at that time resulted in no improvement and until now only dry dressing had been used. The ulcer measured 6 by 8 cm and it continued to remain that size. It was situated over the lateral malleolus of the left ankle and was surrounded by an area of induration in which there was a 2-cm rim of erythematous tissue. The skin was dry and flaky over the entire lower extremity. Culture from the ulcer showed coagulase-positive Staphylococcus aureus. Treatment with elevation, moist packs, and antibiotics resulted in marked improvement in the appearance of the ulcer but there was no change in its size or character. The entire ulcer and surrounding skin were removed down to the periosteum and a split thickness skin graft was applied. The graft took well, but the pathologist report on the excised tissue described a well-differentiated squamous-cell carcinoma. One month later it was noted that there was recurrence of tumor in the lower half of the grafted area. The patient recalled having received x-ray treatment in 1942 for chronic lichen planus and in 1952 for psoriasis. No record of the amount of x ray given was available. Amputation was carried out and invasiveness of the carcinoma was observed. A squamous-cell carcinoma such as this could arise in chronically inflamed, scarred, or ulcerated tissue. However, because of the absence of a history of trauma, this ulcer probably arose as a result of changes secondary to excessive radiation received during treatment for chronic skin disease. Low-voltage radiation such as is used in skin diseases may be more prone to cause malignant degeneration. The often reported radiation dermatitis, burns, and later squamous-cell carcinoma which develop after excessive exposure to fluoroscopy and other x-ray procedures implicates excessive exposure to radiation as a causative factor in squamous-cell carcinoma of the skin. (BBB)

**31989** CHILD AND X RAYS. (CURRENT PROBLEMS IN PEDIATRIC ROENTGENOLOGY). Schall, L. Monatsschr. Kinderheilk., 112: 231-3(Apr. 1964). (In German)

In the field of pediatric x-ray studies technical advances cause interest to shift from one organ system to another. The skeletal system has had and still retains a leading position. Studies of the lung have increased considerably from a rather small beginning. Currently, differential diagnosis of infantile pneumonia is a problem in this area. Cardiac and mediastinal studies have always been of interest. The development of methods for surgical correction of congenital cardiac defects has made angiocardiography more of a routine procedure, and introduced new roentgenological problems. Studies of the abdominal area, central nervous system, and urological studies have received attention from an early period. However, interest in irradiation of the thymus has abated since its peak of several decades ago. One major problem associated with irradiation of infants and small children has been the question of radiation injury. For greater protection the use of radioisotopes and fluoroscopy has been frequently forbidden. As a substitute the use of x-ray photography has been encouraged for clinical diagnosis. Along with this problem there has been a need for keeping the infant or child immobile during x irradiation. Here it is important to avoid irradiation of personnel who assist in these studies. Even so, the most effective radiation protection is to shorten the exposure time and to avoid technical errors as much as possible. (BBB)

**31990** CALIFORNIUM ISOTOPES PROPOSED FOR INTRACAVITY AND INTERSTITIAL RADIATION THERAPY WITH NEUTRONS. Schlea, Carl S.; Stoddard, Dean H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nature, 206: 1058-9(June 5, 1965). (TID-21832)

The possibility of using $^{252}Cf$ or $^{254}Cf$ as neutron sources for tumor therapy is considered. Dosimetry of the two isotopes is discussed for several types of therapy. (H.G.D.)

**31991** RADIOACTIVE ISOTOPES IN CLINICAL MEDICINE. PART II. Silver, Solomon (Mt. Sinai Hospital, New York). New Engl. J. Med., 272: 515-22 (Mar. 11, 1965).

Use of radioiodine to treat and diagnose various diseases is reviewed, with data on doses required, possible hazards, and comparative results obtained with other methods. In thyroid cancer, if disease persists after surgery, treatment with $^{131}I$ should be considered. If significant uptake is present, as determined by whole-body scanning after tracer doses of 0.5 to 2.0 mC, with or without TSH, treatment is usually started with doses of 50 to 60 mC, which will probably ablate any normal thyroid tissue left behind by the surgeon and remove an efficient competitor for the $^{131}I$. Subsequent doses of 100 to 150 mC are given at intervals of three to six months as long as uptake persists and bone-marrow depression is not demonstrable. By this technique total doses reaching 2000 mC have been given. It has been estimated that the dose to the blood from 100 mC of $^{131}I$ varies from 66 to 260 rad, and the body dose from 20 to 182 rad. As side-effects, radiation sickness, sialadenitis, and occasional induced leukemia have been reported. Testicular atrophy was noted in one patient after 563 mC. Accessible deposits may be treated by conventional radiotherapy or even by excision. Although there is good evidence that external irradiation to the neck in infancy and early childhood increases the incidence of thyroid cancer, there is no evidence for a similar effect from $^{131}I$ as commonly used in diagnosis and therapy. The $^{131}I$ therapy of cardiac disease in euthyroid patients is also considered. Two general approaches have been used. In one, relatively small doses of $^{131}I$, 5 mC, are administered at weekly intervals until the desired result is attained. In the other a larger single dose, 20 to 40 mC, is administered, with no further therapy for several months. The total administered varies from 15 to 200 mC. Because these large doses, especially the first, may result in a radiation thyroiditis, with leakage of preformed hormone into the circulation and a resultant pharmacologic hyperthyroidism, it has been suggested that the retained dose should not exceed 12 mC for any single treatment. The deleterious effects of the radiation thyroiditis can be minimized if antithyroid drugs are given to deplete the gland of stored hormone before the $^{131}I$ is administered. Good results have also been obtained in supraventricular tachcardia and paroxysmal atrial fibrillation with doses of 5 to 6 mC per week for several weeks. Therapeutic use of other radioactive isotopes in polycythemia, the leukemias, malignant

lymphomas, primary hemorrhagic thrombocytosis, and multiple myeloma is also considered. (BBB)

**31992** RADIOACTIVE ISOTOPES IN CLINICAL MEDICINE. PART III. Silver, Solomon (Mt. Siani Hospital, New York). New Engl. J. Med., 272: 569-74(Mar. 18, 1965).

The use of $T_2O$, $^{22}Na$, $^{24}Na$, $^{35}S$, $^{40}K$, $^{42}K$, $^{28}Mg$, $^{86}Rb$, $^{45}Ca$, $^{32}P$, $^{85}Sr$, and other isotopes to investigate body water and mineral metabolism are outlined. Equilibration of $T_2O$ is complete in a few hours after an intravenous dose, and a sample of urine or plasma at that time is representative of the general body concentration of the labeled water. Two isotopes of sodium are available, $^{24}Na$, with a half-life of 15 hr, and $^{22}Na$, with a half-life of 2.6 hr. However, the biologic half-life of sodium is short so that the usual doses, 50 to 100 $\mu$C, are acceptable. At 24 hr, about 94% of the total exchangeable sodium is measured, and this represents about 80% of the total body sodium. The available isotopes of chlorine are not suitable for clinical use, and $^{82}Br$ as the bromide can be used to measure exchangeable chloride, with an error of not more than 1%. Calcium-absorption studies are greatly simplified by isotopic technics; 10 mC of $^{47}CaCl_2$ with 200 mg of the stable salt as carried is administered by mouth, to measure the unabsorbed $^{47}Ca$ in the stool or study blood levels. For bone tumors diagnosis, the bone seekers, $^{72}Ga$, $^{18}F$, $^{47}Ca$, $^{85}Sr$, and $^{87m}Sr$, have been used. Osteoblastic lesions are most clearly demonstrated, but purely lytic lesions may be missed. Scanning may detect lesions, especially metastatic ones, that are overlooked on x-ray study. Because of the high energy of the $\gamma$ ray of some of these isotopes, special shielding and collimators are required. The use of radiocobalt for vitamin $B_{12}$ studies, and various isotopes for liver and kidney studies, and for fat absorption is also considered. The bibliography includes 206 references. (BBB)

**31993** STUDIES ON HOMOGENEITY OF DOSE DISTRIBUTION IN TUMORS. 3. COBALT-60 TELETHERAPY. Yamashita, Nobuo (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 310-17(June 1964). (In Japanese)

Tables and charts are provided which show the distribution of the $\gamma$-ray dose for various tissue depths and skin-source distances (SSD) with a $^{60}Co$ teletherapy apparatus. The values obtained were based on the dose distribution considered on the basis of the primary and scattered beams in relation to points on the central axis using John's data for the calculations. The scatter to points off the axis was obtained as follows. The field was considered as an infinite series of arcs in terms of Clarkson's method at any point off the axis for a circular field, and the scatter values were obtained for a full circle corresponding to the average radius of the arcs calculated by the second elliptic integral. Heterogeneity index, as defined previously, was calculated by the above method under the following conditions: SSD 80 cm, assuming the radius of the tumor to be from 2 to 6 cm. The results were as follows. For one-field irradiation, when SSD was constant, the heterogeneity index increased with the increase of the tumor radius. When the tumor depth in the body changed, the heterogeneity index also changed slightly. The heterogeneity index of $^{60}Co$ $\gamma$ irradiation was less than a half that of 200-kv x rays. For two-field irradiation, the variation of heterogeneity index was about 1 to 3%, and for four-field irradiation it was <1%. (BBB)

**31994** THYROID UPTAKE TEST. Klebanoff, S. J. (Univ. of Washington, Seattle). Northwest Med., 63: 797-802(Nov. 1964).

The use of the uptake of radioactive iodine by the thyroid as a test of thyroid function is discussed, including the many variations in the procedure which have been introduced, as well as the variations in dose, in type of isotope used, and in time and frequency of the measurements. Use of isotopes other than $^{131}I$ is considered. Advantages in the use of $^{132}I$ for routine iodine uptake tests stem from its half-life of 2.26 hr as compared to 8 days for $^{131}I$. Thus repeated tests can be conducted on the same individual with relatively short intervening periods and with negligible correction for background. Its short half-life results in a markedly reduced radiation exposure to the thyroid gland as compared to $^{131}I$; thus, the dose to the thyroid in rad/$\mu$C of administered $^{132}I$ is 1 to 3% of that of $^{131}I$. Because of this, children and pregnant women can be tested with greater safety. Thyroid scanning, which requires a higher dose of radioiodine, can be done at an earlier age. The $\gamma$ rays of $^{132}I$ have considerably higher energies than those of $^{131}I$ which makes collimation in scanning operations more difficult with $^{132}I$. The effects of accidental spillage are more temporary. The disadvantage of a short shelf life is minimized by the fact that the isotope is obtained as its parent, $^{132}Te$ with a 77-hr half life absorbed on a column of alumina. Iodine-132 is formed from the decay of $^{132}Te$ and is separated from Te as needed by elution from the alumina column with dilute ammonium hydroxide. The effective shelf life of $^{132}I$, then, is that of its parent, $^{132}Te$ at 3.2 days as compared to 8 days for $^{131}I$. Only after elution does the 2.3 hr half life become the governing one. Following elution, $^{132}I$ is regenerated and may be again eluted from the column after a short lapse of time. Because of its short half life, $^{132}I$ is employed in tests in which the early uptake of iodide is measured. A disadvantage to its use is the inability to perform $PB^{132}I$ (protein-bound iodine) measurements 48 to 72 hr after administration. The $^{125}I$ isotope has a half life of 57.4 days and its advantages stem from this long half life and from the fact that it decays by electron capture with the emission of soft photons in the 0.027 to 0.035 Mev energy range. Despite the considerably longer half life of $^{125}I$, the radiation exposure to the thyroid gland during complete decay of $^{125}I$ is about $\frac{1}{2}$ that obtained with $^{131}I$ starting with same initial disintegration rate due to the virtual absence of $\beta$ particles. The absence of $\beta$ particle emission from $^{125}I$ makes this isotope particularly suited for the labeling of radioactive compounds. The shelf life of these compounds is considerably prolonged, because of the long half life of the isotope, and the reduced radiation damage to the chemical compound. Thus $^{125}I$ triiodothyronine may be preferred to $^{131}I$ triiodothyronine in the in vitro red blood cell or resin binding test. The low energies of the x and $\gamma$ rays of $^{125}I$ result in 100% absorption by suitable scintillation detectors in in vitro measurements and, therefore, in very high counting efficiencies. In vivo measurements, however, are made more difficult because of the low energies of the photons emitted from $^{125}I$. An isotope of iodine, such as $^{131}I$, which emits stronger $\gamma$ rays, may be used in a second iodine uptake following the one employing $^{125}I$, with the radioactivity of the former being filtered out readily because of its softness. The use of $^{125}I$ for photo-scanning of the thyroid for a cold nodule near the surface of the organ gives greater precision because the soft photons emitted from the underlying tissue are absorbed by the nodule leaving a clearer image. However, substernal goiters may not be so readily demonstrable with $^{125}I$ due to absorption by the overlying bone. (BBB)

**31995** EVALUATION OF STATIC AND ROTATION-CONVERGENT METHODS OF THE X-RAY TREATMENT OF PARAMETRIAL RECURRENCES OF CANCER OF THE UTERUS PREVIOUSLY TREATED BY RADIATION. Skowronska, Irena; Skowronski, Stefan; Jach, Krzysztof (District Oncology Center, Poznan, Poland). Nowotwory, 14: 33-9(Jan.-Mar. 1964). (In Polish)

Dose estimation, isodose contours, avoidance of untoward radiation reactions, and cure rate were evaluated with two techniques using 180- to 200-kv x radiation. The results were recorded in 45 cases with parametrial recurrences of the cancer of the cervix following earlier radiation therapy. The cases are divided into two groups in which the different techniques of irradiation were applied. In 27 cases a static method of irradiation was used with several portals. In 8 cases, a 5-yr cure was obtained. These results were obtained in patients with recurrences, less advanced than those with edema of the lower limbs. Following x-ray treatment two patients had mild rectal inflammatory symptoms with favorable outcome, and no other postirradiation complications were noted. In 18 cases with far-advanced

parametrial recurrences the rotational convergent method of irradiation was applied. This consisted of combining the rotational movement of the x-ray tube with synchronized movement in the perpendicular direction providing continuous focusing of the beam of radiation toward the central point. With such a beam, a high concentration of the dose to the tumor was obtained, the skin dose being small. This way it was possible to deliver 130 to 170% of the skin dose to the tumor, giving a total of 2300 to 3000 R to the tumor. In 8 cases distinct subjective improvement followed and in 7 cases objective improvement, but generally improvement was brief, in two cases it only lasted 15 and 24 months. The method was well tolerated by patients and intensive skin radiation reactions were absent. Delivering high doses to the tumor by this method in the less advanced recurrences should also give good results. (BBB)

**31996** POLYCYTHEMIA VERA AND PREGNANCY: REPORT OF A CASE. Ruch, Walter A.; Klein, Richard L. (Army Hospital, Fort Campbell, Ky.). Obstet. Gynecol., 23: 107-11(Jan. 1964).

The case report is presented of a 26-yr-old woman who was treated with $^{32}P$ for polycythemia vera and who underwent two subsequent pregnancies. Although a stillborn infant resulted from the first, the second pregnancy was normal. After diagnosis of this disease, between Sept. and Dec., 1958, periodic phlebotomies totaling 5000 ml satisfactorily controlled the hemtocrit, but platelet and white blood cell counts markedly increased. Leukocytic alkaline phosphatase activity was neither as low as characteristic of chronic granulocytic leukemia nor as high as typical of polycythemia vera. In Apr., 1959, 4.5 mC of $^{32}P$ was administered intravenously. A maximal effect occurred in four months, with return of blood counts to normal and reduction of spleen size. The patient became pregnant for the first time in Dec., 1959. During the first trimester, her blood pressure was normal. Blood counts reached minimal levels during the second trimester (Apr. 1960), and then rose sharply in July, coinciding with increased blood pressure and retarded pregnancy size. Neither edema nor proteinuria was present. The uterine fundus was smaller than normal for a 35-week gestation, rising just above the umbilicus; fetal heart tones disappeared. Labor was begun in August, and the patient delivered a 1058-g macerated, stillborn fetus too decomposed to permit autopsy. The fetus was extensively purpuric. The patient again became pregnant five months later. Blood counts during this pregnancy duplicated the pattern established in the first, but the blood pressure remained within the normal range. She delivered a 2956-g. female infant in Oct., 1961, without complications. Blood studies on the child were normal. There is a paucity of information concerning pregnancy in women with polycythemia vera. The only other formal report of this association describes a 29-yr-old patient followed for 18 years, including four pregnancies, none of which continued to term. The first two terminated in stillborn deliveries at 5 and 7 months; the last two resulted in living children born in the last month of gestation. Radiation therapy which produced a significant reduction in red cell count preceded each successful pregnancy by less than one year. Hypertension and proteinuria developed in the three pregnancies which continued more than six months. (BBB)

**31997** LEUKAEMIA IN NEW ZEALAND AND AUSTRALIA. Gunz, F. W. (Christchurch Hospital, N. Z.). Pathol. Microbiol., 27: 697-704(1964).

Between March 1, 1958, and December 31, 1961, a survey was conducted in New Zealand to investigate cases of leukemia to determine the incidence and type distribution of the disease, and the frequency of factors of possible etiologic importance. Cases of leukemia and myelomatosis throughout the country were reported to a central registry as soon as possible after diagnosis and investigated by means of a questionnaire. Cases were classified as acute (A), chronic granulocytic (CG), and chronic lymphocytic (CL). There were adequate reports on 590 cases of leukemia, 122 of myelomatosis (M), and 712 controls. For various types of leukemia in Australia the overall incidence was about 6 per 100,000, with 20% of cases occurring before the age of 15, another 20% between 15 and 50, and 60% after the age of 50. Approximately 60% of all cases are acute, 25% chronic lymphocytic, and 15% chronic granulocytic. In an analysis of possible causative factors, exposures to diagnostic irradiations were recorded for the 10 yr preceding the onset of leukemia or, in controls, of the disease for which the patient was under treatment. Exposures were excluded if they were made for the diagnosis of symptoms subsequently found to be caused by leukemia, or, in controls, the disease for which the patient was under treatment. Dental x rays were also excluded. Exposures were roughly quantitated according to the probable skin doses received and also to the probable marrow doses. Skin doses did not disclose any definite differences between the groups. Further calculations showed a possible slight predominance of relatively heavy diagnostic exposures in some patients with A and CG, but according to these figures it is unlikely that more than 1% of all cases of A and CG could have been caused by diagnostic irradiation. The results suggest that it is justifiable to attribute the leukemia of 11 patients with A or CG to the action of therapeutic x irradiation. A summary of the findings in the leukemia survey suggests the following previously recognized factors as being concerned in the causation of the disease in the patients indicated: familial factors, 10 patients; mongolism, 5 patients; therapeutic irradiation, 11 patients; or a total of 25 patients (4.5% of the 590 cases). Preliminary evidence from Western Australia confirmed the existence of sizeable numbers of leukemia patients with histories of heavy exposures to radiotherapy and of others with first-degree relatives with leukemia. (TCO)

**31998** RADIOLOGY AND THE PRACTITIONER. V. OBSTETRICS AND GYNECOLOGY. Sutton, David (St. Mary's Hospital, London). Practitioner, 192: 690-6 (May 1964).

The use of radiology in obstetrics has recently been a matter for controversy in the medical press. Increasing use of radiology was being made in the practice of obstetrics until 1956 when a report was published suggesting that there is a relation between antenatal exposure of the fetus to radiation and the later development of leukemia in children. This report has been strongly criticized on statistical and other grounds and regarded by many as exaggerated and unproven. The recent publication of further evidence suggests that although there may be a slight increase in the incidence of leukemia among children who have had antenatal radiation, this increase is much smaller than was originally suggested. This slight risk, if it exists, is generally regarded as far outweighed by the help provided by radiology in many difficult obstetric problems. However, these surveys have led to improvements in radiological technique in an attempt to reduce the amount of antenatal exposure to a minimum. In most obstetric examinations patients now receive much reduced x-ray doses as compared with ten years ago. In view of this controversy it is also clear that there must be a definite clinical indication for the x raying of the pregnant patient and that the necessity for antenatal examination should always be critically examined. Where there are definite indications, however, there should be no hesitation in making use of the valuable information that radiology can provide. A discussion is provided of use of radiology in obstetrics for three main purposes: (1) pelvimetry and the study of disproportion, (2) assessment of the fetus as regards position, abnormality, maturity, and multiple pregnancy, (3) placental localization. The experienced obstetrician can assess most cases of disproportion or suspected pelvic abnormality on clinical examination, and only occasionally will he require the confirmation of radiology, particularly in borderline cases. Before the recent controversy about antenatal radiation it was customary for four or more projections of the pelvis to be taken. Now most radiologists use only two, or at the most three, views. These enable the radiologist to decide that there is, or is

not, severe disproportion, and to measure the important diameters. Radiology in the diagnosis of pregnancy is unreliable until about the 16th week, although occasionally fetal parts may be recognized as early as the 12th week. Most requests for radiological confirmation of pregnancy at an early stage arise if there is clinical doubt as to whether a pregnancy, a pelvic tumor, or a hydatidiform mole is present. Placental localization by radiographic methods is of considerable value in a suspected case of placenta previa. Several methods are available, but the safest and simplest is by x rays. With good-quality films the placenta, particularly if it is in the upper uterine segment, can be readily identified in most cases. Various other uses of x-ray diagnosis in pregnancy are discussed. (BBB)

**31999** RECTAL COMPLICATIONS OF RADIATION TREATMENT OF CANCER OF THE UTERUS. Leiva, Juan Carlos Villaggi. Prensa Med. Arg., 49: 571-9 (Mar. 9, 1962). (In Spanish)

Ten cases of rectitis secondary to radiotherapy are described. Various previous schemes of classification of the lesions are examined, and a new classification proposed. Five grades, increasing in severity, are recognized on the basis of rectosigmoidoscopy: Grade 1, congestive, edemic, and hemorrhagic rectitis; Grade 2, ulcerative rectitis; Grade 3, ulceronecrotic rectitis; Grade 4, stenosing rectitis; and Grade 5, fistulizing rectitis. Histopathologic examination reveals inflammatory changes in the rectal mucosa combined with changes in the stroma and muscular tunic, including vascular damage and impairment with anoxia and metabolic depression. Epithelial modifications include glandular dilatation, hypersecretion of mucus, epithelial hyperplasia and cellular atypia, and even destruction of epithelium in the ulcerated zone. The stroma shows edema, inflammatory cell infiltration, and ultimately sclerosis. The muscular layer may show degeneration and atrophy of the muscle fibers. Vascular alterations are seen as dilatation of the vessel lumina, thrombosis and endarteritis, and sclerosis of the blood vessel walls. Symptoms of radiorectitis may appear one week to six years after treatment, on an average of six months, and are characterized by pain, diarrhea, and passage of mucus and blood. Diagnosis is best confirmed by rectosigmoidoscopy and radiology. A barium enema series will show stenosis and incipient fistula formation if present. In most cases of acute rectitis occurring soon after irradiation, healing is spontaneous and no further pathology develops, but in rare cases the rectitis may evolve into severe lesions. However, the late development of radioinduced rectitis accounts for most of the severe lesions, which may take three main forms: proctorrhagia, and fistula (either with the bladder or vagina). The ten cases of rectitis observed by the author are described in detail. Most of these cases had received both Ra and x-ray therapy for uterine cancer. The doses were as high as 10,560 mg-hr of Ra and 11,690 R of x rays over four fields in 40 applications. Three of these patients developed fistulas. The principal treatment given for rectitis consisted of adrenal steroids; antibiotics; enemas containing streptomycin, pectin, and aluminum hydroxide; and supplements of vitamin A. Three patients required surgical treatment. (BBB)

**32000** THE APPLICATION OF A 14-Mev NEUTRON SOURCE TO RADIOTHERAPY. Greene, D. (Christie Hospital and Holt Radium Inst., Manchester, Eng.) and Lomer, P. D. Proc. Roy. Soc. Med., 58: 161(Mar. 1965).

The 14-Mev neutrons were produced by accelerating D ions on to a T target in a sealed tube. The advantage of this reaction is that it gives a useful yield of neutrons at accelerating voltages of the order of 100 kv, so that the tube can be comparable in size to a diagnostic x-ray tube and a conventional high voltage supply can be used. In terms of neutron output, as total particles emitted per sec, it was estimated that to obtain a dose rate equivalent to 50 rad/min of x rays at 50 cm from the target, $10^{12}$ neutrons per sec (n/sec) would be required. The present experimental generator gave an output of $10^{10}$ n/sec with a target life of more than 100 output hr. To increase the output it is necessary to increase the beam current which raises problems about target heating and subsequent loss of T. Design studies, done before the possibility of the application to radiotherapy was raised, show that outputs up to $10^{12}$ n/sec should be feasible. Present efforts in tube development are directed towards achieving an output of $10^{11}$ n/sec and are progressing. The neutrons are emitted isotropically from the target and in order to utilize them for radiotherapy it is necessary to limit them to a well-defined beam. The problem in designing a suitable collimator is to find a material which will give such a beam at a usable distance from the target. Experimental results show that steel is the best material for this purpose. The results of some measurements obtained with an experimental steel collimator, 14-in. thick, compared the dose distributions across the beam edge, in air, and at different depths in a scattering medium, with those obtained with conventional and megavoltage x rays. The dose distribution across the edge of the neutron beam was comparable with that obtained with conventional x rays. Depth dose measurements in water and in tissue-equivalent solution for a 20 × 15 in. field at 80 cm FSD were comparable with those for $^{60}Co$ $\gamma$ rays at the same field size and FSD. There was a slight buildup of dose below the surface over the first three mm. (BBB)

**32001** FRACTIONATION STUDIES WITH 6-Mev NEUTRONS AND 8-Mev X RAYS. Morgan, R. L. (Hammersmith Hospital, London). Proc. Roy. Soc. Med., 58: 162 (Mar. 1965).

Although the early clinical results were encouraging, late tissue damage was a disappointing complication and has discouraged the use of neutron therapy ever since. The 6-Mev neutron beam produced by the Medical Research Council 45-in. Cyclotron at Hammersmith Hospital was used to investigate neutron effects on pigskin in an attempt to provide a rational explanation of the late effects observed clinically. Pigskin was irradiated with fractionated doses of 8-Mev x rays and 6-Mev neutrons and the subsequent reactions observed for at least three months and up to three years. It was found that the relative biological effectiveness (RBE) of fast neutrons increased with the number of fractions into which the radiation dose was divided. In addition, for similar early reactions no progressive increase in tissue damage in the neutron-irradiated areas was observed in periods up to three years after the exposure. The neutron doses previously prescribed clinically had been based on single-exposure RBE estimates and a knowledge of the increase in x-ray dose necessary with fractionation in clinical practice. It is suggested that the late tissue damage observed clinically was due to the increase in RBE with extended fractionation, as shown by the pigskin results, an effect that was not known at the time of the neutron clinical trials. Clinical advantages and possibilities of fast-neutron therapy are discussed. Fast neutrons of 6-Mev energy have an oxygen enhancement ratio (OER) or about 1.7 compared with about 3 for x rays of the energies used in radiotherapy. Consequently, anoxic tumors should respond better to fast-neutron irradiation than to x rays. Normal tissues which are anoxic, such as cartilage, are also likely to show an enhanced radiation effect and until the effects of fast neutrons on such tissues are better understood, tumors close to or involving cartilage should be avoided in any trial or neutron therapy. With the limitation of radiation dose to normal tissues familiar to radiotherapists, the 6-Mev neutron beam delivers to anoxic tumors a biologically effective dose about 1.6 times greater than that delivered by 8-Mev x rays. Such a gain factor may provide a clinically useful improvement in therapeutic results. (BBB)

**32002** THE USE OF X RAYS AS A RESEARCH INSTRUMENT: PROBLEMS IN ANIMAL BIOLOGY. Foxon, G. E. H. (Guy's Hospital Medical School, London). Proc. Roy. Soc. Med., 58: 164-5(Mar. 1965).

Circulatory problems are especially suitable for the application of radiographic methods; with small animals the field to be radiographed is small and the problems involved in making a rapid sequence of exposures are readily over-

come. Such methods were used to study the passage of Thorotrast in the common frog and the green lizard. Thorotrast also can be used in the study of the activity of the recticuloendothelial system in vertebrates and the corresponding systems in invertebrates. Thorotrast has an advantage over some other contrast media in such studies in that it can be distinguished in a histological section from other particulate matter by autoradiography, as it is an $\alpha$ emitter. Thus macroscopic and microscopic appearance can be correlated with considerable precision. Treatment of soft tissues with fixatives containing salts of mercury makes them radio-opaque in varying degrees, allowing radiographs to be made with 30-kv x rays of materials which, without such fixation, could only be obtained by using much softer rays. X-ray studies of small invertebrates made by this method may result in great economies of time when used in place of the standard zoological techniques which involve staining and clearing. Radiography is useful in investigating and recording many aspects of animal anatomy and even in the study of fossil fish, when embedded in a matrix of favorable radio-opacity. (BBB)

**32003** THE USE OF X RAYS AS A RESEARCH INSTRUMENT. THE MEASUREMENT OF THE MINERAL CONTENT OF LIVING BONES. Doyle, F. H. (Postgraduate Medical School, London). Proc. Roy. Soc. Med., 58: 165-6 (Mar. 1965).

Various attempts to measure radiographically the mineral content of living bones are described. The usual x-ray method is to make a radiographic exposure of the bone together with a suitable standard for bone mineral; from the resulting radiograph, a photometric comparison of the bone and standard is then made. Another technique is the measurement of attenuation of a highly collimated x-ray beam or a photon beam from a radioisotope source. A $^{125}I$ source gave a high degree of accuracy in the measurement of the mineral content of the shaft of the radius. This method is capable of further refinement, and by using photons of different wavelengths from more than one isotope source, more than one substance or element can be estimated. The two-kilovoltage x-ray method is also described. Another method involves neutron activation of bone followed by measurement of the radiation emission from the Ca isotopes present. The method depends on a knowledge of the abundance of stable Ca isotopes in bones. (BBB)

**32004** RADIOISOTOPES IN THE DIAGNOSIS AND TREATMENT OF CANCER. Brucer, Marshall. Progr. Clin. Cancer, 1: 74-95(1965).

Numerous aspects of the use of radioisotopes in clinical medicine are reviewed, with discussion of the hazards and side-effects. There has been a shift of emphasis from teletherapy (the source a long distance from the body), to brachytherapy (the source actually in the body but sealed against participating in any metabolic function), to mechanical placement (the source unsealed but probably not participating in any metabolic function), to a metabolic placement where a very specific metabolic function and localization is expected. The direct injection of radioactive materials into tumors has never been very successful. A portion of the lack of success may have been due to the fact that the early radioactive materials were substances such as phosphorus that had a normal metabolism of their own and there was no real confinement of the radioactivity for very long. Therefore, the idea of direct injection was shifted to materials that were of a chemical nature that did tend to remain where they were injected. There is considerable controversy on the risks of causing acute leukemia or radiation damage to patients treated with large amounts or radioisotopes. The numbers of patients involved in examples of these alleged risks are always few compared to the numbers of patients benefited. Even more important, the risks seem minute in comparison with the failures in the therapy of the original disease. If true, and these additional risks are certainly possible, then radiation damage is one of the minor risks of cancer therapy. Results of radioisotope therapy is still disappointing. The diagnostic uses have been far more rewarding and hence more extensively studied. The early diagnostic uses of radioisotopes were with what would now be considered enormous doses. One hundred to 200 $\mu$C was common for $^{131}I$. As soon as instruments allowed, dosages were reduced to 50 or 30 $\mu$C. With the changeover from Geiger-Mueller to crystal detection, the diagnostic dose was reduced to 25, then 15 $\mu$C. With an increase in the size of the crystal detector, even this amount became unnecessary. Long before it became officially demanded, many physicians using advanced equipment were demonstrating improved diagnostic techniques with even lower doses. The concept of the exempt dose is discussed. With the exception of scanning, radioisotope diagnostic procedures can be done with amounts in the exempt quantities level. Most procedures can be repeated many times a year without any biological danger. Legal dangers, however, are always present and probably will continue to be present even if tracer amounts are used. Much of the diagnostic use of radioisotopes in oncology has been related to the detection of specific localization. The obvious biochemical changes that can be followed with such radioisotopes as carbon and tritium have not yet been adapted to widespread clinical use. Most of the diagnostic tests (blood volumes, various absorptions, localizations, translocations, and excretions) are adaptable to both malignant and nonmalignant diseases. Many of the tests have been confined to the radioiodine isotopes. Improvement in detection instruments, commercial distribution of diagnostic drugs, and the release from overbearing federal regulations by the adoption of exempt quantities could make the diagnostic use of radioisotopes practical. (BBB)

**32005** REGIONAL OXYGENATION AND IRRADIATION IN THE TREATMENT OF MALIGNANT TUMORS. Mallams, John T.; Balla, George A.; Finney, James W. (Baylor Univ., Dallas). Progr. Clin. Cancer, 1: 137-53(1965).

Radiobiological basis of the use of $H_2O_2$ perfusion, as a means of increasing the oxygen content of tissues, to enhance tumor radiosensitivity is discussed, and the technique and results obtained in patients are described. In addition, in vitro and in vivo experiments were conducted to demonstrate the effectiveness of $H_2O_2$ in raising tissue oxygen tension. The two in vitro studies used diluted plasma in one and a solution of Ionosol-T with catalase (100 units/ml) and hydrogen peroxide, in the other. The diluted plasma saturated with gaseous oxygen had an average oxygen content of 1.8 vol %. The quantity of oxygen in solution at 5 min after the addition of 0.5% $H_2O_2$ was equivalent to between 4.6 and 12.4 atm. In an Ionosol-T-catalase and $H_2O_2$ system, the oxygen content stayed above eight atm for more than 2 hr. In vivo studies were conducted on rabbits, bubble formation could be seen with intra-arterial infusion of either 0.24 or 0.36% $H_2O_2$ when delivered at 3.75 ml/min; it seemed to create no major problem for the animal infused. In this model system, reproducible results were obtained that indicate the relation between concentration and flow-rate of hydrogen peroxide. In a clinical trial, 102 patients were treated, utilizing regional oxygenation and external irradiation. Three regions were satisfactorily treated: (1) head and neck regions exclusive of brain; (2) abdomen and pelvis; and (3) extremities. For the head and neck regions the external carotid or the common carotid artery is used for infusion, unilaterally or bilaterally. The patients were infused daily with a fresh solution, 250 ml, of Ionosol-T with dextrose to which was added 25–50 mg of tolazoline (Priscoline) and 5 to 40 ml pharmaceutical grade 3% $H_2O_2$. The resulting solutions are about 0.06 to 0.48% $H_2O_2$. The patient received radiation during the infusion of the last 60 to 70 ml of the peroxide solution. The only side-effect noted was arteriospasm. Local mechanical blocking of the capillary bed may also occur if the system is overloaded and capillary bubbling occurs. Originally the radiation doses were limited to 85% of the standard acceptable techniques, but lately 100% irradiation doses have been used. No irradiation morbidity has been seen to date, nor any observable increase in normal tissue reaction. Normal tissue repair was markedly accelerated in many patients. Biopsy specimens showed normal repair as early as four

days following the beginning of irradiation, while tumor damage progressed. Selected cases are described which demonstrate the increased radiation sensitivity of tumors as follows: (1) the cure of tumors of moderate radiosensitivity with a sublethal dose (normally 40 to 50% of lethal doses), as demonstrated in three patients; (2) the cure of tumors of resistance above normal tolerance with a dose in the normal tolerance range. (BBB)

**32006** INTERNAL MAMMARY RADIATION IMPLANTS. Brasfield, Richard D.; Henschke, Ulrich K. (Memorial Hospital for Cancer and Allied Diseases, New York). Progr. Clin. Cancer, 1: 450-2(1965).

The importance of the internal mammary lymph nodes in breast cancer and other lesions of the pectoral region is emphasized. Metastases in the internal mammary nodes in women with breast cancer are 45% from the inner quadrant, 22% from the outer quadrant, and with an average of 33% from all quadrants. To take advantage of the close proximity of these nodes to the internal mammary vessels (97% within 1.5 cm, 87% within 1 cm), an intravascular $^{60}$Co wire was devised as a source of irradiation. High doses of irradiation can then be easily delivered within one week. The surgical technic of implantation is described. Immediately after the radical mastectomy has been performed but before the skin flaps are closed, a Nylon catheter is inserted in the internal mammary artery at the first interspace. A $^{60}$Co wire is then inserted into the catheter. The 27-gauge wire is 20 cm in length; however, the proximal 5 cm is inactive. This protects the skin from excessive irradiation near the point of exit. A $^{60}$Co wire of 15-mg radium equivalent will deliver 9000 R to a 1 cm cylinder of tissue in 7 days. The half life of $^{60}$Co is 5.2 years, which will allow the treatment of over 250 patients with each wire. This simple technic is painless and adds only 10 min to the operating time, and is much less expensive than x-ray therapy to the internal mammary nodes. Follow-up since 1957 has indicated that 9000 R delivered to the parasternal nodes is safe, but more time is needed to thoroughly evaluate this procedure. (BBB)

**32007** MASSIVE PREOPERATIVE IRRADIATION IN THE TREATMENT OF OSTEOGENIC SARCOMA. Francis, Kenneth C. (Hospital for Special Surgery, New York). Progr. Clin. Cancer, 1: 774-6(1965).

The technique and the value of massive preoperative irradiation as a treatment for osteogenic sarcoma in children are discussed. Since an initial report of 15 patients treated by massive irradiation followed by amputation, a total of 70 selected patients have been treated from 1951 to 1964. Each patient was thoroughly studied throughout the course of treatment. Blood chemistry, including serum calcium, phosphorus, alkaline phosphatase, and total protein, was obtained preirradiation, during irradiation, at the completion of irradiation, and postamputation. The method of treatment consists of the administration of 10,000- to 12,000-Rad tumor doses through two opposed fields using 1000-kv x rays, over a period of 6 to 8 days. Amputation was performed within 2 to 3 days following completion of the irradiation. The results in the first 33 patients treated by this method are now surveyed 5 yr or over since amputation. Seven patients (21%) are now alive and well with no evidence of metastases after 5 yr or more. The results in a comparable series of children with osteogenic sarcoma who did not receive preoperative irradiation show that at 5 yr after amputation, three of the 25 cases were alive and well (12%). Analysis of the unsuccessful cases in the two series showed that the children who received preoperative irradiation lived longer than those who did not. This comparison indicates that massive preoperative irradiation followed by amputation within a few days does not jeopardize the patient as regards either curability or length of life. (TCO)

**32008** CALCULATION AND MEASUREMENT OF ISODOSES FOR BIAXIAL PENDULUM IRRADIATION OF TUMORS OF THE UTERUS IN CONVENTIONAL RANGE OF X-RAYS. Tautz, M. (Radiologische Klinik, Stadische Klinikum, Berlin). Radiobiol. Radiotherap., 6: 257-69 (1965). (In German)

A method for calculating the radiation dose in any point in transversal section of the adjusting plane in pendulum irradiation of the small pelvis is presented. Errors were critically considered. The comparison with the measuring results points to the importance of the method of calculation for the individual irradiation planning. (tr-auth)

**32009** CHANGES IN PROPERDIN SYSTEM IN MALIGNANT TUMORS AND UNDER THE ACTION OF CONVENTIONAL X-IRRADIATION. Reissmann, G. Radiobiol. Radiotherap., 6: 275-83(1965). (In German)

Beginning with the detection of a properdin-complement system, new insights into the nature of unspecific reactions of infections were given. Persons with malignant tumors could not be found to have a lower properdin titre than normal experimental persons. On the contrary, properdin values in sick persons with malignant tumors are considerably higher than in normal persons. Under x-ray therapy with conventional radiation there is as opposed to animal experiments with whole-body irradiation no decrease in properdin level. Not before the 14th day of irradiation series with 10,000 to 12,000 R of grid irradiation does a significant decrease occur. All results of examination where checked by modern statistical methods. Finally, the causes of decreasing the titre under x-ray therapy are discussed. (tr-auth)

**32010** CLINICAL INVESTIGATIONS OF THE INFLUENCE OF VITAMIN $K_3$ ON BRONCHIAL CARCINOMA UNDER RADIATION THERAPY. Becker, H. W. (Martin-Luther-Universitat, Halle/Saale, Ger.). Radiobiol. Radiotherap., 6: 285-94(1965). (In German)

In 147 cases of inoperable bronchial carcinoma the effects on survivals of administration of vitamin $K_3$ additional to radiation therapy were studied. The data of three years were divided into two groups according to the alternating progression. Additional to radiation therapy the patients of one group received 100 mg vitamin $K_3$ were intravenously injected one hour before irradiation. The maximum age of both groups was between 55 and 65 years. Central bronchial carcinomas of the upper lobe were most frequent. In 56 per cent of cases diagnosis was made by bronchroscopy and bronchography. In two thirds of all cases diagnosis was assured within six months after the first symptoms had occurred. Of the patients irradiated for bronchial carcinoma six months after treatment 40 per cent survived, after 12 months 16 per cent and after 24 months 4 per cent were still alive. A significant difference of survivals of the patients irradiated for bronchial carcinoma with and without an additional administration of vitamin $K_3$ was not found statistically. Reasons of the failure of additional treatment with vitamin $K_3$ and of the generally bad figures of recovery of bronchial carcinoma are discussed. (tr-auth)

**32011** RADIOIODINE SCANNING IN DISEASES OF THE THYROID GLAND. Kuhl, David E. (Hospital of the Univ. of Pennsylvania, Philadelphia). Radiol. Clin. N. Am., 1: 101-14(Apr. 1963).

The technique and results of $^{131}$I scanning in thyroid disorders are described. Radioiodine scanning can be useful in solving three principal problems which involve the diseased thyroid gland: (1) Is a thyroid nodule more likely a benign or a malignant one? (2) Are thyroid carcinoma metastases present and do they concentrate iodine? (3) Is a mediastinal mass of thyroidal origin? The application of scanning to these three problems is based on: the inability of a malignant thyroid nodule to accumulate radioiodine in a higher concentration than that of a normal thyroid gland; the frequent ability of differentiated thyroid carcinoma metastases to concentrate some radioiodine, especially in the absence of the thyroid gland; the probability that a substernal thyroid extension will concentrate some radioiodine. The technique used a 2 × 2 in. NaI(Tl) crystal and a 19-hole focusing collimator, the efficiency of which was adequate for thyroid scanning. For improved counting efficiency, however, a detector having a 3 × 2 in. NaI(Tl) crystal and a 61-hole focusing collimator with 2 in. of lead side wall shielding was used. During scanning the 364-kv

photopeak of $^{131}I$ is selectively counted, using pulse height discrimination. An oral dose of 50 $\mu$C of sodium iodine ($^{131}I$) is given for a scan of the thyroid. A larger dose of 1 mC of $^{131}I$ is given to a patient with proved thyroid carcinoma if metastases are to be identified. The patient is usually scanned 24 hours after the dose of $^{131}I$. The normal and pathological distribution of $^{131}I$ in the body are described. After ingestion, radioiodine is absorbed rapidly in the proximal small bowel and passes into the iodide space of the body which is in equilibrium with the plasma. From there it is largely either excreted in the urine or concentrated in the thyroid gland. Normally, from 15 to 45% is concentrated in the thyroid gland in the first 24 hr, and most of the rest excreted in the urine at the end of two days. A small percentage of the iodine dose concentrates in other body sites and can be important in scanning interpretation. Iodine can be detected in the salivary glands and saliva early after administration, and this appearance should not be misinterpreted as indicating cervical node metastasis. Radioiodine is also secreted by the stomach wall, and a gastric image is a common finding on any scan extending below the diaphragm. Radioiodine is excreted in the urine so that radioactivity should be expected in the bladder for several days. It was possible to demonstrate metastases by scanning in five patients with thyroid gland uptake of greater than 15% at 24 hr, but four of these patients had already had one lobe removed prior to scanning. More commonly, metastases are identified only after the entire thyroid gland is excised or ablated with $^{131}I$. It is best to scan the patient six weeks after total thyroidectomy, using a large (1-mC) tracer dose of $^{131}I$. If significant normal thyroid tissue remains in the neck, an ablating dose of 50 mC of $^{131}I$ is given and the patient is scanned eight weeks later. (BBB)

**32012** X-RAY TELEVISION AND RADIATION INJURY. Frik, W. (Universitat, Erlangen, Ger.). Radiologe, 4: 146-53(May 1964). (In German)

The factors which may affect the radiation injury that a patient may receive and the magnitude of the source in the region of fluoroscopic instrumentation should be the constant concern of every physician who takes x rays. The amount of radiation injury that may be produced during fluoroscopy depends on several factors. The first of these is the dose potential at the input of the radiation screen used which is required for recognition of details. This may involve the usual fluoroscopic shield, the shield at the input of the x-ray image intensifier, or the face of some other amplification system. Another factor is the use of a raster for scattered radiation. When a raster is used the patient receives almost twice as much irradiation as compared to when it is not used. The decision to use a raster depends on the degree of contrast desired. The effects of field size and compression do not depend on the amplification system, but more on the physician's technique. Exposure time is not markedly affected by improved light amplification, because the improved picture produced tends to encourage lengthened viewing time. The size, dimensions, and relative transparency of the patient may also affect exposure to radiation injury. Using television equipment, the amount of radiation injury is decreased only with the thinner patient, as compared to conventional viewing. In very thick patients good recognition of details can be obtained with television equipment only at the cost of increased irradiation exposure. However, if dose potential is controlled automatically it is possible to decrease exposure by ~40% with television equipment. (BBB)

**32013** MEDIUM DEPTH THERAPY BY MEANS OF COMBINED IRRADIATION WITH FAST ELECTRONS AND ULTRAHARD X RAYS. Vieten, H.; Heinzler, F. (Institut und Klinik fuer Medizinische Strahlenkunde, Medizinische Akademie, Dusseldorf, Ger.). Radiologe, 4: 206-8(July 1964). (In German)

Combined irradiation with fast electrons and ultrahard x rays results in summation of the depth dose curves of both types of irradiation, with the advantage that the 80% isodose lies within the range of ~1 to 5 cm, with a dose maximum of 100% at 2 to 3 cm. The dose falls rapidly with increasing depth to 50% at 7 cm. Beyond this the decrease is less steep, because only the x irradiation remains effective. The surface dose is ~60%. These values can be improved if the irradiation is alternated in differing time-dose fractionation. Since the dose maxima of both types of irradiation lies near the same depth, the same dose, such as, for example, 200 R, can be administered at 24-hr intervals. With alternation of irradiation either the surface or the deeper areas receive the equivalent of the dose maximum. However, if longer intervals, with alternation of higher and lower dose can be used at 48 hr, experience shows that focal doses of 7000 to 8000 R can be given without exudative skin reactions. After irradiation of lymphatic tumors in the supraclavicular regions and at depths where the lungs are located no radiogenic changes have ever been observed. (BBB)

**32014** THE TUMOR DOSE IN THE PRACTICE OF COBALT TELETHERAPY. Pereira, Adelino (Hospital A. C. Camargo da Associacao Paulista de Combate ao Cancer, Sao Paulo, Brazil). Rev. Brasil. Cirur., 45: 429-32(June 1963). (In Portuguese)

Two different ways for calculating the radiation dose in the treatment of tumors with $^{60}Co$ are described. In the first method, considering a constant skin-focus distance, the dose ($D_s$) at a skin depth of 0.5 cm is calculated before the tumor dose ($D_t$) is computed, where $D_s = Rt$ (R = roentgen/min at a distance d, and t = time of irradiation in min). The tumor dose, $D_t$, is calculated from the expression: $D_t = D_s\Delta$, where $\Delta$ expresses three variables: divergence of the beam $D_v$, absorption factor $A_b$, and secondary radiation $R_s$. Thus, $\Delta$ as a depth dose factor includes $D_v$, $A_b$, and $R_s$. Expressions are derived for each of these factors, leading to an evaluation of $\Delta = (d/d + h)^2 \cdot e^{-\mu h} \cdot (1 + \alpha)$, where d = skin-focus distance, h = tumor depth, d + h = tumor-focus distance, and $\alpha$ = a constant $\geq 0$. The value of $\Delta$ can be verified experimentally or obtained from Johns' tables (cf. H. E. Johns, Brit. J. Radiol., 25: 302(1952)). Several examples are given showing the usefulness of this calculation. In the second method the dose is calculated to the middle of the tumor, considering the focus-tumor distance to be constant. In this case dose rate at the tumor $R_t = D_t/D_a$, where $D_t$ = tumor dose and $D_a$ = central tumor dose, and $D_{t,} = D_t\Delta$, or $D_t = D_s \cdot (d/d + h)^2 \cdot e^{-\mu h}(1 + \alpha)$. Then, $D_a = D_s \cdot (d/d + h)^2$, giving $R_t = e^{-\mu h}(1 + \alpha)$. A table is reproduced which gives $R_t$ in terms of field area and tumor depth. An example is provided illustrating this calculation. In this form, $R_t$ is independent of the skin-focus distance over the range 40 to 100 cm for $^{60}Co$ $\gamma$ radiation. (BBB)

**32015** PROLONGED REMISSION AFTER RADIATION THERAPY AND BONE MARROW TRANSPLANTATION IN A PATIENT WITH LYMPHOSARCOMA. Miller, D. G. (Memorial Sloan-Kettering Cancer Center, New York). Rev. Franc. Etudes Clin. Biol., 10: 84-6(Jan. 1965). (In French)

Six years after the initial diagnosis of lymphosarcoma a 45 year old male had generalized progression of the disease with bulky regional lymphadenopathy, bone marrow invasion, and pancytopenia. After the lymph nodes were treated with local irradiation 900 R (in air to each of 6 portals encompassing both sides of the neck, each axilla, and groin); the lymph nodes regressed, but the hematological picture became progressively worse. He then received a transfusion of bone marrow from a donor with sickle cell trait. The number of sickle cells reached 205 per 1,000 red cells 24 hours after this procedure but their number fell progressively over the next 3 months. A skin graft applied at the time of the bone marrow graft was rejected. Starting at four months, there was a gradual improvement in the peripheral blood and bone marrow, and all hematological values returned to normal. Liver, spleen, and palpable lymphoid masses also decreased in size with no treatment. Eighteen months later there was a relapse with the development of new lymphosarcoma masses, but hematological remission persisted for 3½ years. The improvement seen in this patient, especially in the bone marrow, cannot be attributed to the localized irradiation of

lymph nodes. While the improvement may have been spontaneous one may also consider the possibility that it was the result of a graft versus host reaction following the transfusion of allogenic bone marrow. This is the only instance of such improvement seen in 21 bone marrow transfusions performed in 13 patients with leukemia or lymphoma. (auth)

**32016** POSTOPERATIVE AND POSTIRRADIATION LESIONS OF THE LOWER URETER. (ETIOPATHOGENESIS AND CLINICAL ASPECTS). Mendez, Dario Pisani (Istituto Oncologico Luis Razetti, Caracas). Rev. Venezolana Urol., 13: 279-98(July-Dec. 1961). (In Spanish)

The pathogenesis, diagnosis, treatment, and prevention of distal ureteral lesions consequent to radiotherapy, usually for cervical carcinoma in women, are the topics of this report. The author's cases, as well as those referred to in 20 earlier reports, are considered. Lesions in the lower third of the ureter occur in about 1% of minor and 10% of major gynecologic operations and in variable frequency after irradiation for uterine cancer. The postirradiation ureteral lesion consists of devitalization of the walls of the vessel with loss of peristaltic elasticity, reduced caliber of the lumen, and fibrosis, usually of the terminal portion, resulting in stenosis and hydroureter. The diagnosis of this condition is considered in terms clinical, radiologic, and cystoscopic symptoms. Interruption of urine flow may result in anuria, uremia, and hypertension. Complete unilateral obstruction usually produces pain in the lumbar region and abdominal distension. Radiologic signs include ureteral dilatation, pyelocalcification, terminal ureteral narrowing, and extravasation of the contrast medium. Radiographs indicating such changes are illustrated. Cystoscopy in postirradiation ureteral stenosis will often reveal narrowing of the orifice, with edema and hyperemia in the region of the meatus. The differential diagnosis of this condition from vesicovaginal and ureterovesicovaginal fistulas and from urinary incontinence of other origins is explained. The importance of periodic examinations postirradiation in the detection and early treatment of ureteral stenosis and hydroureter is emphasized. (BBB)

**32017** RADIOTHERAPY FOR ANKYLOSING SPONDYLITIS: A REVIEW. Sambrook, D. K. (Swansea Hospital, Eng.). Rheumatism, 19: 30-40(Apr. 1963).

In view of the reported increased incidence of leukemia of patients with this disease treated by x rays, the technique, its benefits, and hazards are examined and reevaluated. Since this treatment was initiated about 30 yr ago, many thousands of sufferers have been treated by radiotherapy in clinics throughout the world, and most clinicians consider it to be of great value. Undoubtedly, radiotherapy can relieve the symptoms of ankylosing spondylitis in most cases, at least temporarily; however, a certain body of opinion deprecates the use of this method of treatment as dangerous and no more effective than simpler and safer medical measures. The original method was wide-field x irradiation to the whole trunk, using small doses, and was based on the dubious theory that x rays stimulated the natural resistance of the body to the disease. This method has been superseded by one in which localized fields of irradiation are directed to the affected parts of the spine and to other affected joints or muscle attachments, and higher dosage is given. Although it is no longer believed that x rays have a general stimulant effect, the exact pathological process, and mode of action of x rays in this disease remain obscure. A review of eight published studies of the use of x rays in this disease shows complete relief of symptoms in 67%, and marked or moderate relief in 21%, i.e., only 12% did not respond. However, longer follow-up showed a progressive decline in the percentage remaining symptom-free with lapse of time. At one year, only 43% remained pain-free, at 3 years 33%, and at 10 years only 22%. However, some of these patients were relieved again by further radiotherapy. The author reports favorable results in a series of 97 patients given 250-kv x rays by a daily fractionated method, the course generally lasting 2 to 4 weeks. Moderate dosage was used, even though it may result in a slightly higher recurrence rate. Only 15% had 2000 R or over (incident dose) to the spine, the average dose being 1400 R. The average dose to peripheral joints was 900 R. The immediate results of treatment were excellent, and in many early cases the benefit appeared to last indefinitely. The hazard of irradiation most feared is the possible induction of leukemia. An occasional case had been observed before 1950, and suspicion was strengthened after reports of seven cases of myeloid leukemia occurring between 1949 and 1954 in patients who had had deep x-ray therapy for ankylosing spondylitis. The Medical Research Council sponsored investigation in 1955, based on a study of 9364 patients who had been irradiated for ankylosing spondylitis, showed that such patients run between 5 and 10 times the risk of developing leukemia as compared with the general population of males in the same age groups in England and Wales. A more extended survey in 1957 of the records of 13,352 patients treated at 81 British Radiotherapy Centers between 1935 and 1954 showed that the mortality from leukemia was about ten times greater than the mortality in a normal population of the same age and sex distribution. The dose/incidence relation based on a sample of cases, assuming a simple proportional relation to dose, with no threshold for induction of leukemia, gave a dose to the whole marrow which would double the expected incidence of leukemia to be between 30 and 50 R. In clinical practice, where usually only the spine is irradiated, this means that with moderate dosage (about 1000-R skin dose) the long-term death-rate from leukemia would be about three per 1000. The latent period between irradiation and maximum incidence is between 3 and 5 yr. Aplastic anemia (which may sometimes really be aleukemic leukemia) is also increased in a similar ratio—to a rate of one per thousand (or less), again with a latent period of 4 to 5 yr. After 10 years most of the risk is past, and patients are not at a uniformly increased risk for the rest of their lives. The total risk is estimated, taking a pessimistic view, at around five per 1000 treated. Considering the suffering and crippling which the disease can cause, if not checked, a treatment which is 99½% safe may be acceptable. Another hazard of irradiation in spondylitis which must be considered is damage to the gonads. Thus 13 cases of permanent amenorrhea have been reported in 47 female patients treated, but this hazard can be largely circumvented. If the sacroiliac joints, hip joints, or ischial tuberosities are irradiated by fields applied directly (i.e., perpendicular to the surface) over these structures, the ovaries will most probably lie within the x-ray beam. Although lying at a considerable depth, they may receive up to 50% of the incident dose. With an incident dose of 1000 to 1500 R this means that they will receive 500 to 800 R, which is enough to cause permanent amenorrhea. It is probably best to avoid irradiating any part of the pelvis in a young woman, if this can be avoided. If the disease is actively involving the hip joints, the prospect of serious crippling is such that the risk may have to be taken. In such cases fields should be small, and dosage limited to below 1000 R (incident dose). If symptoms arise from the sacroiliac joints, the risk of sterilization can be reduced by outward angulation of the x-ray beams, so as to leave the ovaries outside the main beam. Measurements showed that with such glancing fields, the ovaries only receive about 75 R for a skin dose of 1500 R. This may be expected to lead to a doubling or trebling of the natural mutation rate, but is unlikely to cause any overt developmental abnormalities in children born subsequently. Nine-tenths of patients with this disease are young men, and gonad shielding is desirable, more to limit harmful recessive mutations than because of the small risk of sterility, since the testes are unlikely to come within the x-ray beam. Measurements with an ionization chamber beside the scrotum, showed a dose of 1 to 2% of the skin dose during irradiation of the sacroiliac joints, from scattered radiation. This can be reduced to a negligible level if the testes are enclosed during treatment in a flexible lead sheet. Other more remote hazards include the possible reactivation of

pulmonary tuberculosis, and aggravation of pre-existing renal disease. Irradiation sickness during treatment, if it occurs, can usually be relieved by pyridoxine or cyclizine, and is seldom a serious problem. (BBB)

**32018** IMPROVED RADIATION PROTECTION BY MEANS OF TESTED AUXILIARY EQUIPMENT FOR X-RAY EXAMINATION OF CHILDREN. Krogmann, Mathilde (Christian-Albrechts-Universitaet, Kiel). Roentgen Bl., 15: 1-7(Jan. 1962). (In German)

Various straps and pillows that can be used to hold children in various positions required for x-ray examinations are described. The devices used prevent motion of the child during the time the x-ray photograph is taken, and thus prevent blurred images. In addition, the devices eliminate the need for medical personnel to hold the children in the proper position during the x-ray examination. The child can be positioned exactly as desired, without injury. Accidental falls from the examination table are avoided. The straps and pillows are available in various sizes to conform to the various sizes of children to be examined. Illustrations of the use of the restraining devices are given for several types of x-ray views. These include thoracic, abdominal, spinal column, skull, arms, legs, etc. Practical experience with these devices shows that parental anxiety for the child examined is avoided, and that the overall radiation exposure received by patient and medical personnel is markedly reduced. (BBB)

**32019** A NEW TYPE OF X-RAY PHANTOM. Hewson, B. (Agfa AG, Leverkusen-Bayerwerk, Ger.). Roentgen Bl., 15: 369-71(Nov. 1962). (In German)

An x-ray phantom that incorporates a human skeleton within a material with properties of x-ray absorption and scattering identical to normal tissue has been developed. There was no great difficulty in using a skeleton in this manner, except that only Asiatic skeletons, which are smaller than European skeletons, were available. The wires that hold the bones together were replaced with Nylon threads so that no shadows would be cast on x-ray photographs. Many of the materials tested to represent human tissue were either too expensive or otherwise too impractical to use, but the one finally accepted was relatively inexpensive, and possessed the properties of absorption and scattering required. The external form of the phantom was shaped by means of a plaster cast in a normal posture, and is covered by a skin-like layer of Plexiglas. The great weight of the material and the difficulty of bringing the phantom into position for x raying made it necessary to construct the phantom in five detachable sections. This phantom makes it possible to test and evaluate physical factors and dose distributions at any kv range of x ray, for any portion of the human body. (BBB)

**32020** SHADOW-FREE PALPATION WITH A PROTECTIVE X-RAY GLOVE. Schorr, Hermann. Roentgen Bl., 16: 398(Dec. 1963). (In German)

In order to improve the ability to palpate organs and tissues during the course of x irradiation or x-ray photography, a device transparent to x irradiation has been developed for use with a Pb protective glove. The device consists of a spoon shaped fitting constructed from Al or Plexiglas. This is worn over the first two fingers of a protective x-ray glove. The distance between the spoon and finger tips is short enough to permit pressure to be exerted effectively by the attached instrument, but at the same time it is long enough to keep the fingers out of the direct x-ray beam. With this attachment palpation can be carried out during fluoroscopy or even during photography with hard x rays. The device combines the advantages of transparency in the surface that exerts the pressure with the radiation protection afforded by the glove. Differences in pressure, strength, and direction can be readily exerted with this device. (BBB)

**32021** X-RAY EXAMINATIONS IN ANIMALS. Henscel, Ekkehard (Freie Universitat, Berlin). Roentgenpraxis, 17: 191-6(Aug. 1964). (In German)

Radiation protection practices to be used in the radiologic examination of large animals are recommended. (BBB)

**32022** HIGH-VOLT THERAPY FOR ARTHROSES AND INFLAMMATIONS. Wieland, Cuno; Kuttig, Helmut (Universitats-Strahlenklinik, Heidelberg). Strahlentherapie, 127: 44-8(May 1965). (In German)

Based on 350 patients, who had radiation therapy with telecesium because of arthroses and inflammatory joint diseases, the question of efficiency of high-voltage therapy in comparison to conventional deep x ray therapy is discussed. Results of treatment were at least equal to results with conventional deep x ray therapy, possibly better. With radiation of recurrences, the higher depth dose and the lower radiation to the skin are advantageous. Purchase of a conventional deep x ray therapy apparatus in addition to an establishment for high-voltage therapy therefore does not appear to be necessary for radiation of inflammatory joint lesions and arthroses. (auth)

**32023** REPORT ON THE PERFORMANCE OF INFLAMMATION IRRADIATION WITH TELECOBALT APPARATUS. Keim, Hubert (Stadt. Krankenhauses, Kaufbeuren/Allgau, Ger.). Strahlentherapie, 127: 49-52(May 1965). (In German)

Inflammation irradiation may be done effectively with telecobalt sources, as shown by a series of 277 irradiations. Results obtained are equivalent or better to those obtained with x rays. (auth)

**32024** EXPERIMENTAL STUDIES ON THE DOSE DISTRIBUTION IN USES OF SATELLITE DIAPHRAGMS OF LEAD FOR TELECOBALT THERAPY. Weishaar, Julius; Wunder, Klaus; Reuss, Albrecht (Universitats-Frauenklinik, Erlangen-Nuremburg). Strahlentherapie, 127: 53-64(May 1965). (In German)

Measurements were done in phantoms in order to obtain the percentage dose distribution for certain focus-surface-distances, field sizes, and diaphragms made of lead. Several factors were tested in preliminary investigations: most suitable holding devices for the diaphragm, influence of holding devices and lead bricks on scattered radiation, and the influence of the diaphragms-surface distance of the build-up effect. (auth)

**32025** OBSERVATIONS OF THYROID CARCINOMA IN CHILDREN. Taper, H.; Zwykielski, Gr. (Inst. of Pathologic Anatomy, Academy of Medicine, Gdansk, Poland). Studii Cercetari Endocrinol., 15: 247-51(1964). (In Roumanian)

Dose data on the use of $^{131}I$ to treat children with thyroid cancer are given. (BBB)

**32026** THE TRANSPLANTATION OF ORGANS. Hardy, James D. (Univ. of Mississippi, Jackson). Surgery, 56: 685-705(Oct. 1964).

This review, mentioning 82 references, considers the use of ionizing radiation and other immunosuppressive agents in preventing the homograft reaction in organ transplantation. (BBB)

**32027** SKIN AND NECK CANCER FOLLOWING RADIATION THERAPY FOR BENIGN DISEASES. Takahashi, Shinji; Kitabatake, Takashi (Nagoya Univ. School of Medicine, Japan). Tohoku J. Exptl. Med., 84: 349-59(Jan. 25, 1965).

To obtain information on incidence of radiation-induced cancer, a survey was made of cases of cancer which developed after radiation therapy exclusively for benign diseases in major hospitals in Japan during 1961 and 1962. Survey cards were sent to these hospitals, selected by the Japanese Hospital Director, which were requested to fill out the questionnaires consisting of prior radiation data in cancer patients. Out of 8923 cancers surveyed, 61 had a history of prior radiation treatment over the same area as that where cancer later developed. Of these 61, there were 54 cancers of the skin or of the neck region. There were 14 skin, 29 thyroid, and 11 neck cancers, excluding thyroid cancer. The ratio of male to female in natural skin cancer in Japan is 3:2; however it is 6:1 in radiation-induced skin cancer, showing the tendency toward higher incidence of skin cancer in the male after irradiation. In thyroid cancer, the male-to-female rate of incidence is 1:2 in

natural cancer, and 1:3 in radiation cancer. The average age of natural skin cancer patients was 59 years, while that for radiation skin cancer was 58 years. On the other hand, in thyroid cancer, radiation-induced cancer tended to occur more frequently in the younger ages under 40 years. The average carcinogenic age was 47 in natural thyroid cancer, while it was 41 years in radiation cancer. This is explained by the fact that most cases of the radiation thyroid cancer patients received radiotherapy for tuberculous cervical lymphadenitis in childhood. The radiation thyroid cancer which developed after irradiation for other than cervical lymphadenitis occurred at the similar age level as natural cancer. The distribution of the latent period between irradiation and carcinogenesis was 3 to 47 years with an average of 19.8 years. Thyroid cancer had the shortest latent period. The radiation doses estimated in each case are tabulated. When length of the latent period was plotted against the radiation dose in thyroid cancer, which was most frequently seen in this series, no inverse proportional correlation between length of the latent period and radiation dose was seen. Therefore, to show a correlation between the dose given and the latent period, the latent period was divided into 6 classes, that is, 3 to 5, 6 to 9, 10 to 15, 16 to 19, 20 to 29, and 30 to 39 years, and an average radiation dose was calculated in each latent period class. In the group with the latent period of 3 to 5 years, cancer may have developed before irradiation, but if this group is excluded, the latent period showed a possible inverse proportion to radiation dose. (BBB)

**32028** LEUKEMIA AND IONIZING RADIATION IN JAPAN. II. INCIDENCE OF LEUKEMIA OF PATIENTS OF BREAST CANCER TREATED BY RADIATION. Sakka, Masatoshi (Tohoku Univ., Sendai). Tohoku J. Exptl. Med., 85: 12-15(Feb. 25, 1965).

Six cases of leukemia are reported which occurred from 1953 to 1960 in women of 40 to 48 yr of age who had undergone radiation therapy between 1941 and 1956. The latent period ranged from one to ten yr in cases where doses were recorded. In a case where the record of dose was lacking, leukemia was found 18 years after first radiotherapy. Japanese statistics for mortality from leukemia of adult females over 20 yr old are examined. These data are discussed and attempts made to compare them with data of the cases described. Incidence of postradiotherapeutic leukemia in comparable age classes is numerically equal to six divided by product of the number of breast cancer cases treated by radiation and mean life span after radiotherapy. The value of population at risk, in man-years is difficult to obtain directly, but is estimated on certain assumptions which are outlined. The first assumption is that the rate of mortality of the breast cancer was constant from 1941 to 1960. It is denoted M and the previous value of 0.65 applied. The second assumption is that all the patients of breast cancer had been treated by surgery and that a fraction of patient group received postoperative radiotherapy. The rate of postoperative radiotherapy, R, i.e., the number of patients irradiated divided by all patients operated, was 0.72 in 1963. For the period considered here a lower value, 0.55, was applied. The third assumption is that incidence is equal to mortality in leukemia. Mean life expectancy after postoperative radiotherapy was calculated to be 3.5 yr. The mortality from breast cancer listed in Japanese statistics in total numbers from 1941 to 1956 is 20,400 persons. The number of postoperatively irradiated population at risk of leukemia was $20{,}400 \times R + M \times 3.5$ man-years, where R = 0.55 and M = 0.65. Therefore, 60,000 man-yr is the total population at risk. The expected frequency of leukemia in the adult female population in general (below 19 yr of age excluded) which has same age distribution as the irradiated patients with breast cancer was estimated by a procedure which resulted in 1.58 leukemia cases per $10^{-5}$ man-yr for period in question. The number of leukemia cases expected in the irradiated population is given by $np + 3\sqrt{npq}$ where n = 60,100 (persons), $p = 1.58 \times 10^{-5}$ (man-yr$^{-1}$) and $q = 1 - p \cong 1.00$. The observed value of 6 is larger than expected value, 0.95 + 2.91 = 3.86, and the difference is significant. (BBB)

**32029** ON THE SIGNIFICANCE OF FLUOROSCOPY FOR THE RADIATION BURDEN TO PATIENTS. Pape, R.; Zakovsky, J. (Wilhelminenspitals, Vienna). Wein. Z. Inn. Med. Grenz., 45: 173-80(May 1964).

In order to reduce irradiation burden from fluoroscopy the current should be limited to 0.5 ma or less, and the viewing time should be limited to not more than one min. Under optimal conditions the average fluoroscopic dose to the thorax may amount to only slightly more than that from a thoracic photograph. Thoracic fluoroscopy should be undertaken only if the abdomen and gonads are shielded with leaded rubber sheets. The gonadal dose is not greater than a little above normal background. If proper precautions are used for gastrointestinal fluoroscopy the irradiation dose may be less than for a photograph. In females the gonadal dose is about 10 to 20% of the abdominal surface dose. Use of a 6-mm Al filter is suggested for these studies. The usefulness of fluoroscopic studies of the genitourinary system is limited, but precautions similar to those for gastrointestinal studies are recommended. An image intensifier is recommended for use with genitourinary surgery. The use of the image intensifier and television monitor circuits present new possibilities for decreasing the irradiation burden imposed on the patient by fluoroscopy. However, these represent advances which are not in general use as yet. If proper precautions are taken with more conventional equipment, the irradiation burden can be lessened considerably. (BBB)

**32030** ON THE IRRADIATION BURDEN IMPOSED ON THE PREGNANT WOMAN AND EMBRYO DURING X-RAY STUDIES. Pape, R.; Zakovsky, J. (Wilhelminenspitals, Vienna). Wien. Med. Wochschr., 114: 24-7(Jan. 4, 1964). (In German)

When x-ray studies are made of the extremities and skull the irradiation that the abdominal area receives in pregnant women is less than 1 mR. It is greater during studies of the knee or femur, or neck and shoulders. The abdomen should be shielded. Thoracic studies result in a dose of 2.5 mR at 3 cm distance from the edge of the thoracic field, and 1.5 mR at 5 cm. Using a protective apron the dose to the fetal gonads from scattered irradiation is still several mR. Use of an image intensifier will not reduce the dose given, but it will improve the picture brightness. Images obtained from pregnant patients in the prone position give doses of about 200 mR/R of incident dose in the dorsal third of the body, and about 100 mR at medium depths. During early months of pregnancy the dose to the embryo and maternal gonads can be considered to be 10% of the incident dose, or of the order of 100 mR. In later months the fetal gonadal dose may amount to about 300 mR. The embryonal gonads receive about 10 to 15% of the incident dose during a lateral abdominal photograph. The maternal gonads receive an average of 1200 mR and the fetal whole-body dose is 400 mR. In axial craniocaudal studies the fetal gonad dose may be as high as 3000 mR. (BBB)

**32031** THE SIGNIFICANCE OF THE COMBINED TREATMENT METHOD FOR REDUCTION OF LATE RADIATION INJURIES IN CERVICAL CARCINOMA. Nowikowa-Stern, L. A. (Academy of Medical Sciences, Moscow). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 31-3(1963). (In German)

Patients with cervical carcinoma in stages I, II, and III were treated with combinations of preirradiation with x ray and surgery, or preirradiation and surgery plus irradiation with implanted Ra. The preirradiation dose given was estimated from the characteristics of the primary tumor, its size, growth form, etc. Out of 86 patients with stage I tumors who had been preirradiated and operated on, two developed fistulas. None of 22 patients in stages II and III developed fistulas with this treatment. Out of 45 patients treated with preirradiation, surgery, and Ra implants 1 in stage II and 2 in stage III developed fistulas. Comparative results of preirradiation on the frequency of cures showed that for 90 patients with stage I tumors 74% were cured by surgery without preirradiation, and of 105 preirradiated, 82.9% were cured. None of 3 patients with stage II tumors were cured by surgery alone, but out of

49 treated with preirradiation plus surgery, 67.3% were cured. None with stage III tumors were cured by any of the treatments. Not only is the number of postoperative complications decreased by irradiation, but also it may improve results obtained with surgical treatment. (BBB)

**32032** ON THE TREATMENT OF CERVICAL CARCINOMA WITH ULTRAHARD RADIATION. Gietzelt, Fritz; Degner, Wolfgang; Schmidt, Hiltrud; Horst-Meyer, Horst zur (Humboldt-Universitat, Berlin). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 55-60(1963). (In German)

Patients were treated with moving telecobalt irradiation in two axes 4 cm to each side of the midline, with an angle of 160°. The field width was 8 cm, at a height of 12 to 15 cm. The irradiation given amounted to 1000 R weekly. The total dose received by the parametrium and pelvic wall was between 5500 to 8000 R. Of 34 patients with stage I tumors, 94% became symptom free. There were two recurrences. In 54 patients with stage II tumors, 72% showed complete regression of the primary tumor. In 28 patients with stage III tumors and extension into the pelvic wall, 32% became symptom free. Out of 13 with stage IV tumors, only 15% became symptom free. In these patients the tumor had invaded the bladder or rectum. Of 5 invasive vaginal carcinomas only 2 showed clinical regression of the tumor. Out of 19 with recurrent invasive vaginal tumors, 52% became symptom free. Biaxial telecobalt pendulum irradiation is preferable to Ra treatment because late complications, such as endometritis, necroses, fistulas, hemorrhage, proctitis, and emboli are avoided. Bone fractures are less likely to occur. This treatment procedure also gives a more homogeneous irradiation of the lymphatic system in the area treated. (BBB)

**32033** LATE CHANGES IN THE REGION OF THE EFFERENT URINARY TRACT AFTER IRRADIATION OF CERVICAL CARCINOMAS WITH ULTRAHARD X RAYS. Oberheuser, Friedhelm (Universitat, Hamburg). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 61-5 (1963). (In German)

Treatment consisting of a combination of 4000 mg-hr of irradiation from implanted Ra, and 2250 R of conventional x irradiation administered in 14 doses of 125 R each to abdominal and gluteal fields, plus 1200 to 1500 R administered to the pelvic wall in 8 or 10 doses of 150 R each, was given to 57 patients with group III cervical carcinoma. Similar Ra treatment, but with 15.5-Mev x irradiation instead of conventional x irradiation was given to 25 other patients. In 20 of the patients, who had shown no evidence of recurrence during 1 to 4 yr postirradiation, who had been treated with conventional x irradiation there was 1 unilateral nonfunctional kidney, 14 with either hydronephrosis or hydroureter, or both, and 5 with ureteral lesions. Only 4 of the 25 patients who had received ultrahard irradiation had these or similar symptoms. In addition to reduction of the frequency of late urinary tract lesions the ultrahard irradiation treatment resulted in improved survival rates. The 1, 2, 3, 4, and 5 yr rates when conventional x irradiation was used were 87, 68, 60, 51, and 48%. When ultrahard irradiation was used, the survival rates for the corresponding intervals were 94, 76, 65, 59, and 70%. (BBB)

**32034** LESIONS OF THE EFFERENT URINARY TRACT AFTER RADIATION TREATMENT OF UTERINE CARCINOMA. Berta, I.; Molnar, Gy.; Toth, F. (Univ. Women's Clinic, Debrecen, Hungary). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 67-8(1963). (In German)

The dose and spatial distribution of irradiation treatment of uterine carcinoma potentiates the possible development of late lesions. The irradiation dosage generally used for invasive carcinoma amounts to between 2760 and 3360 mg-hr by Ra implant, distributed over an interval of 10 to 14 days. After this the patient receives stationary irradiation in four fields of 2100 to 3000 R each, centered on the parametrium. The fractionation amounts to 300 R daily. In inoperable cases $\gamma$ irradiation of 5400 to 7000 mg-hr is given in 3 to 5 sessions. Then the parametrium is x irradiated as described above. No recurrences have been noticed in from 6 mo. to 3 yrs after treatment. In 18% of the cases there was reduction of ureteral capacity, and in 31% cystitis occurred. Using a dye excretion test elimination was found to be reduced unilaterally in 20% of the cases, and bilaterally in 5%. After irradiation 8% showed kidney malfunction. This included nonfunctional kidney 1%, hydronephrosis and hydroureter 1%, massive dilatation of the pyelon and ureters 5%, and ureteral dislocation 1%. The incidence of urinary tract lesions was about twice these values when surgery and irradiation were used as combined treatments. However, surgical procedures do not ensure prevention of recurrences, while irradiation treatment is much more effective for this. (BBB)

**32035** UROLOGICAL FINDINGS AND FOLLOW-UP STUDIES IN WOMEN SUFFERING FROM GENITAL CANCER. Zielinski, Jerzy (II Surgical Clinic of the Medical Academy, Zabrze, Poland). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 75-6(1963). (In German)

Chromocystoscopy is advantageous for each case of cervical carcinoma. Urography is also important, for if dye is excreted within 6 min it indicates that no urinary blockage is present. However, if blockage is present after irradiation treatment the tests should be repeated within 3 months. In 54 patients with blockage caused by infiltration from the parametrium who were irradiated, the blockage decreased or disappeared in only 16. In 12 of the patients the irradiation treatment and the compression of the urinary system by the tumor increased the urological complications. One year after irradiation only 16 were alive. Ten of these were tumor free. Urinary blockage caused by irradiation is relatively infrequent as compared to its frequency observed in tumor cases. Nephrostomy did not improve urinary blockage, because it was caused by tumor infiltration. Nephrostomy increased survival only by 3 to 10 months. Healing of the wound was poor. Unilateral nephrostomy was sufficient to reduce the amount of uremia observed. When anuria is caused by an incurable cancer and the general condition of the patient indicates that survival may be short, the possibility that nephrostomy will be beneficial is reduced considerably. (BBB)

**32036** DOSE DISTRIBUTION IN BIAXIAL PENDULUM IRRADIATION WITH $^{60}$COBALT IN THE SMALL PELVIS. Matschke, Siegfried; Welker, Klaus (Robert-Roessle-Klinik, Deutsche Akademie der Wissenschaften, Berlin). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 77-82(1963). (In German)

The author presents diagrammatic representations of the dose distribution of $^{60}$Co irradiation during biaxial pendulum irradiation. The most important advantage of this method is that by proper choice of field size, pendulum angle, and axial distance the forms of the isodoses and thus the dose distribution can be adapted to physical characteristics of the individual patient. The dose distribution can be varied in almost any desired pattern. In this way organ areas can be selectively irradiated, but compromises must be made sometimes. The calculated value of the dose can be controlled in part by studies with phantoms, using an equidensity method. The calculation can be checked by direct measurements obtained from microdosimeters placed in the rectum and bladder. Agreement is usually so close that it is unnecessary to check the calculations in this way for each patient irradiated. (BBB)

**32037** ON SURGERY IN AREAS IRRADIATED BY X RAY AND COBALT. Kirsch, R. (Chirurgische Klinik des Krankenhauses, Berlin). Wiss Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 83-4(1963). (In German)

The surgical problems presented by patients irradiated for gynecological carcinomas are related to the irradiation dose and the technique used to administer it, the type of irradiation, the interval between irradiation and the surgery proposed, and the location of the irradiation. The

surgeon should excise tissue destroyed by irradiation so that surrounding healthy tissue can heal the wound properly. Irradiation between 6000 and 20,000 R will produce this degree of damage and require surgical intervention. Distribution of irradiation over several fields, use of moving irradiation, or of hard or ultrahard irradiation will reduce damage to the tissue surrounding a tumor. Sieve irradiation has a protective effect on tissue when only irradiation is used, but it has little value when an operation is planned for after the irradiation. The softer the irradiation quality, the less its depth effect. Telecobalt irradiation produces greater tissue damage than conventional x irradiation. Scar formation begins almost immediately when telecobalt irradiation is used, but during an early postirradiation period the tissue remains soft enough to be operated on. Large vessels and the ureters should be repaired with unirradiated tissue to avoid subsequent obliteration or development of stenoses. With conventional x ray more time may be permitted before surgery. The optimal interval is 4 or 5 weeks after irradiation. (BBB)

**32038** ON THE PROBLEM OF LATE INJURIES AFTER TREATMENT WITH THORIUM-X. Kutz, Guenter (Orthopaedische Heil-und Lehranstalt Annastift, Hanover). Z. Orthopaed. Grenz., 97: 474-82(Oct. 1963).

Patients previously treated with ThX for ankylosing spondylitis were studied by sternal marrow puncture. In contrast to previous reports in the literature that indicate that ThX has no effect on hematopoiesis, the author detected anomalies in nuclei of white cell precursors immediately after and for five yr following treatment with ThX, at the rate of 200 e.s. units twice weekly. These types of bizarre cells are found only infrequently if 200 e.s. units are given only once a week, with a total amount of from 2000 to 2400 units. The possibility of appearance of disturbances in leucopoiesis and panmyelopathies at higher dosage levels is discussed. However, if the total blood picture is closely followed during treatment the danger of injury is considerably lessened. The danger of injury with this treatment is probably no greater than if patients with ankylosing spondylitis were given x irradiation. (BBB)

**32039** POSSIBILITIES AND ADVANCES IN RADIATION THERAPY OF MALIGNANT GENITAL TUMORS. Scherer, E. (Staedtische Krankenanstalten, Essen). Zentr. Gynaekol., 86: 457-67(Apr. 4, 1964). (In German)

The current status of irradiation treatment of malignant genital tumors is reviewed with especial emphasis on more recent treatment procedures used with supervoltage therapy. After irradiation with the 15-Mev betatron, survival rates are considerably increased. Telecobalt therapy is also being used increasingly more. The use of supervoltage therapy not only definitely increases the numbers of patients who are cured of genital tumors in advanced stages of malignancy, but it also has the advantages that the skin is spared from injury. For this reason the patient can be subjected to greater dosages of irradiation treatment more readily. Even genital tumors in early stages of development show evidences of significant improvement, at least so far as can be determined at the present time. Some of the dosimetric characteristics of supervoltage therapy are also reviewed as they pertain to treatment of genital tumors, including isodose contours and results of dose distribution studies. Results of treatment of uterine carcinoma by various other linacs are also described. (BBB)

**32040** EXCHANGE LABELING OF DIAGNOSTIC COMPOUNDS, ESPECIALLY OF LIPIODOL ULTRA FLUID WITH $^{131}I$ AND ITS INTRALYMPHATIC ADMINISTRATION WITH A FISTULA INTO THE THORACIC DUCT. Liebster, J.; Kocandrle, V.; Fronkova, K.; Veres, K.; Burger, M.; Charamza, J. (Inst. for Biological Research, Czechoslovak Academy of Sciences, Prague). p.265-71 of "EUR-2200.e."

Methods for the $^{131}I$ labeling of iodinated higher fatty acids and their use in the diagnosis of tumor metastases into lymph nodes or localization of lymphatic fistulas in dogs are reported. A fatty acid, designated Lipiodol ultra fluid, was labeled with $^{131}I$ and the distribution in tumor bearing dogs was compared with that of $^{131}I$-Ethiodol and colloidal $^{198}Au$ for the detection of metastases in regional lymph nodes or fistulas of the ductus thoracicus. (C.H.)

**32041** DIFFERENTIAL DIAGNOSIS OF THE MEGALOBLASTIC ANEMIAS USING $^{14}C$-HISTIDINE, $^{14}C$-PROPIONATE, AND $^{14}CO_2$ BREATH ANALYSIS. Fish, M. B.; Pollycove, M.; Feichtmeir, Th. V. (San Francisco General Hospital, Calif.). p.339-51 of "EUR-2200.e."

Procedures are described for the differential diagnosis of the megaloblastic anemias using $^{14}CO_2$ breath analysis after the administration of $^{14}C$-histidine or $^{14}C$-propionate. Procedures for the evaluation of folic acid deficiency and vitamin $B_{12}$ deficiency are outlined. Design features of a breath analyzer system are described that includes an ionization chamber, a vibrating reed electrometer, an infrared $CO_2$ analyzer, a ratemeter, and a chart recorder, plus a plastic helmet for the patient. (C.H.)

**32042** EFFECT OF THE AUTORADIOLYSIS ON THE RENAL CLEARANCE VALUES OF $^{131}I$ LABELED HYPAQUE AND HIPPURAN. Bianchi, C. (Universita, Pisa, Italy), Hegesippe, E.; Meozzi, E.; Rosa, U.; Sosi, S. p.353-64 of "Eur-2200.e."

The use of Hypaque (3-5 diacetamido 2-4-6 triiodo benzoic acid, sodium salt) and Hippuran (o-iodobenzoic acid, sodium salt) labeled with $^{131}I$ for studies of renal function is discussed. It is pointed out that the presence of free iodine in the solutions can affect trace results, and the formation of inorganic iodine may be the result of decomposition reactions unrelated with radioactivity or of radiolysis. It is suggested that $^{125}I$ be used as the tracer or as a standard when $^{131}I$ is used. (C.H.)

**32043** MEASUREMENT OF INTRACELLULAR pH USING 5,5-DIMETHYL-2,4-OXAZOLIDINEDIONE-2-$^{14}C$, TRITIATED WATER, AND CHLORIDE-36. Schloerb, P. R.; Grantham, J. J. (Univ. of Kansas, Kansas City). p.373-7 of "EUR-2200.e."

Procedures are described for the rapid measurement of intracellular pH using $^{14}C$-5,5-dimethyl-2,4-oxazolidinedione, tritiated water, and chloride-36. The small sample requirements suit the method to the study of intracellular pH in patients. (C.H.)

**32044** BORON-SLOW NEUTRON CAPTURE THERAPY: PRESENT STATUS. Soloway, A. H.; Brownell, G. L.; Ojemman, T. G.; Sweet, W. H. (Massachusetts General Hospital, Boston). p.383-403 of "EUR-2200.e."

The present status of neutron capture therapy of brain tumors is reviewed. Emphasis is placed on the preparation and testing of boron compounds with promise for preferential incorporation into tumors as a carrier for $^{10}B$ for use in the nuclear reaction $^{10}B + n \rightarrow {}^{11}B \rightarrow {}^{7}Li + {}^{4}He +$ 2.4 Mev. The feasibility of using other nuclides and problems associated with dosimetry during neutron capture therapy are discussed. (C.H.)

**32045** GAMMA-RAY IRRADIATION APPARATUS AND SUPPORTING STRUCTURE. Bozoki, Laszlo; Martos, Istvan; Wein, Istvan (to Medicor Rontgen Muvek). U. S. Patent 3,177,365. Apr. 6, 1965. Filed June 20, 1962.

In an irradiation apparatus for medical and scientific purposes, a radiation source is movable from an irradiator head to a storage place through a rigid tube that supports the irradiator head. The entire device can be rotated about a horizontal shaft in such a manner that the beam from the radiation source when it is in the head always passes through a predetermined point. (A.G.W.)

# CHEMISTRY

## General

*Refer also to abstract 31696.*

**32046** (ANL-7020) CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS, MAY 1964–APRIL 1965. (Argonne National Lab., (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 276p. Dep.; $6.00(CFSTI).

The highlights are arranged into the following sections: compact pyrochemical processes, fuel cycle applications of volatility and fluidization techniques, high temperature reactor materials development, calorimetry, reactor safety, energy conversion, determination of nuclear constants, analytical chemistry, and studies and evaluations. Separate abstracts were prepared for each of the sections. (D.L.C.)

*For abstracts of individual sections see: 32055, 32118, 32279, 32280, 32447, 32725, 32924, 33237, and 33588.*

**32047** (KFK-287) VERSUCHE ZUR ZERSTORUNG VON KOMPLEX-UND CHELATBILDNERN IN RADIOAKTIVEN ABWASSERN DURCH OXIDATION. (Research on the Destruction of Complexing and Chelating Agents in Radioactive Liquid Wastes by Oxidation). Krause, Helmut; Hepp, Herbert; Kluger, Wolfgang (Kernforschungszentrum, Karlsruhe (West Germany)). Sept. 1964. 20p. Dep.(mn)

The efficiency of precipitation methods can be seriously impaired by the presence of various complexing and chelating agents. The destruction of these compounds by oxidation with ozone or chlorine was investigated. Both ozone and $Cl_2$ destroyed the chelates of EDTA in aqueous solution. (J.S.R.)

**32048** (NP-15073) RESEARCH IN PROGRESS DURING CALENDAR YEAR 1964. (Army Research Office, Durham, N. C.). 315p.

Research in the physical sciences and mathematics sponsored by the Dept. of the Army is described. The information is presented in sections on physics, chemistry, mathematics, engineering, and metallurgy and ceramics. Indexes of active topics, projects terminated in 1964, contract numbers, contractors and grantees, principal investigators, and subjects are included. (J.R.D.)

**32049** HOW $D_2O$ MAY BE MADE IN SASKATCHEWAN. Can. Chem. Process., 49: 71-5(May 1965).

The processes on which Western Deuterium's contract to produce heavy water in Saskatchewan at a cost of $14.65/lb is probably based are discussed. Equilibration of liquid water with hydrogen gas, followed by $H_2$-liquid ammonia exchange and ammonia electrolysis or $D_2O$ distillation is the most likely scheme. (D.C.W.)

**32050** EXPLOSION OF BURNING ZIRCONIUM DROPLETS CAUSED BY NITROGEN. Nelson, L. S. (Sandia Lab., Albuquerque, N. Mex.). Science, 148: 1594-5 (June 18, 1965).

Single droplets of zirconium were photographed as they burned luminously in free fall. When the oxidizer was oxygen containing small amounts of nitrogen (less than 5%), the burning droplets exploded only when a threshold concentration of nitrogen was exceeded. Explosions also occurred when the zirconium was partially nitrided before being burned in pure oxygen. These experiments prove that the presence of nitrogen can cause the explosion of zirconium droplets burning in oxygen-rich atmospheres. (auth)

**32051** NUMERICAL SOLUTION OF 2- AND 3-DIMENSIONAL SCHRÖDINGER EQUATIONS FOR ANY MOLECULAR POTENTIAL BY ITERATIVE VARIATION OF NUMERICAL TEST FUNCTIONS WITH A DIGITAL COMPUTER. I. THEORETICAL PRINCIPLES—DESCRIPTION OF A COMPUTER PROGRAM FOR SOLUTION OF 2-DIMENSIONAL SCHRÖDINGER EQUATION. Seelig, Freidrich Franz (Universitat, Marburg, Ger.). Z. Naturforsch., 20a: 416-27(Mar. 1965). (In German)

The expectation value of the energy for nonanalytic functions defined in a one- or two-dimensional grating is formulated, starting with the known fact that the solution of the Schroedinger equation for an electron is equivalent to the determination of the test function pertinent to the lowest value of the energy in simultaneous orthogonality of the functions belonging to the various states. From this expression a criterion is developed that makes it possible, from a given test function, to synthesize by iterative point-for-point variation with a digital computer the lowest energy and therefore best function within the limits given. The variance of the final function is calculated but is not used for the control of the computing process. A FORTRAN II program for the calculation of the two-dimensional wave functions is outlined. This was tested for several examples at the IBM 7090 (with 32,768 bits) at the German computer center in Darmstadt. (tr-auth)

**32052** THE STUDY OF CHEMICAL REACTIONS IN CROSSED MOLECULAR BEAMS. Ross, J.; Greene, E. F. (Brown Univ., Providence). p.363-96 of "Energy Transfer in Gases." New York, Interscience Publishers, [1963].

Theory for chemical reactions in crossed molecular beams is outlined, with consideration of elastic scattering; and some experiments on chemical reactions in crossed thermal beams and in beams with velocity selection of one beam are reviewed. (D.C.W.)

## Analytical Procedures

### See also Separation Processes and Procedures.

*Refer also to abstracts 31778, 32596, 32597, 32599, and 32835.*

**32053** (AE-188) TRACE ELEMENTS IN HUMAN MYOCARDIAL INFARCTION DETERMINED BY NEUTRON ACTIVATION ANALYSIS. Wester, P. O. (Aktiebolaget Atomenergie, Stockholm (Sweden)). May 1965. 35p. Dep.(mn).

By means of neutron activation analysis, injured and adjacent uninjured human heart tissue from 12 autopsy cases with myocardial infarction were investigated with respect to the concentration of 23 trace elements. The bulk elements K, Na, and P were also determined. A recently developed ion-exchange technique, combined with subsequent γ-spectrometry, was used. The following trace elements were determined: Ag, As, Au, Ba, Br, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Hg, La, Mo, Rb, Sb, Sc, Se, Sm, Zn, and W. In the injured tissue compared to the uninjured, calculation on a wet weight basis showed a decrease in Co, Cs, K, Mo, P, Rb, and Zn, and an increase in Br, Ca, Ce, La, Na, Sb and Sm. The differences in Ca, La, Mo, P, and Zn are dependent on the age of the myocardial infarction, and the regression lines for these elements are given. The concentration of the trace elements in uninjured tissue from infarcted hearts is compared to the concentration of these elements in normal heart tissue, determined in a previous study. In the uninjured tissue from infarcted hearts a decrease is found in Cu and Mo, and an increase in As and Ce. (55 references.) (auth)

**32054** (AECL-2137) THE DETERMINATION OF CHLORINE IN POLYPHENYL REACTOR COOLANTS AND RELATED ORGANIC COMPOUNDS. Stewart, R. B.; Jones, R. W.; Elchuk, S.; Smith, G. G. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Div.). Jan. 1965. 30p. Dep.; $1.00(AECL).

A rapid method for the analysis for chlorine in polyphenyls and organic solutions is described. It consists of a decomposition of the organic matrix by combustion in

an oxy-hydrogen flame, condensation of the water vapor and hydrochloric acid produced, and determination of the chloride by precision null-point automatic, titrimetry. A sensitivity of 0.5 ppm chlorine is available in low- and medium-viscosity samples, 1 ppm in high-viscosity coolants. (auth)

**32055** (ANL-7020(p.231-7) ANALYTICAL CHEMISTRY. (Argonne National Lab., Ill.).

Some of the activities and accomplishments of the Analytical Chemistry Group are described. They include: burnup monitoring in fast reactors (fission yields of stable Mo, Ce, Ru, and Pd isotopes), chromatography, x-ray diffraction studies of the $UZn_{8.5}-UZn_{12}$ region of the U–Zn system, x-ray spectrochemical analysis of $Al_2O_3$ beds, determination of Mg in its binary alloys, and electron-probe microanalysis which was used to identify new phases in the $UZn_{8.5}-Zn$ region. (D.L.C.)

**32056** (CRDC-1216) FLAME-IN-TUBE ATOMIC ABSORPTION SPECTROPHOTOMETRY: THE DETERMINATION OF IRON IMPURITY IN TERPHENYL REACTOR COOLANT. Mislan, J. P.; Mark, S. J. (Atomic Energy of Canada, Ltd., Chalk River (Ontario)). Feb. 1965. 20p. (AECL-2228). Dep.; $0.50(AECL).

A description is given of the application of atomic absorption spectrophotometry to the determination of iron impurity in terphenyl reactor coolant. A flame-in-tube sampler unit was designed and constructed specifically for this analysis. A description is given of the instrumentation and analytical procedure. The detection limit for iron in the coolant was found to be 0.10 ppm. A comparison is made between the atomic absorption analysis and the x-ray fluorescence method now in routine use. (auth)

**32057** (EUR-2240.f) CALCUL DE LA POSITION DU POINT FINAL DE LA COURBE DE TITRATION POTENTIOMETRIQUE DE L'ACIDE BORIQUE. (End-Point Calculation of the Boric Acid Potentiometric Titration Curve). Le Duigou, Y. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Apr. 1965. 6p. Dep.(mn)

A calculation indicating the localization of the inflexion point of a potentiometric titration curve has been applied to the boric acid determination previously described. Experimentally determined data such as the $pK_A$ were used for this calculation. The result shows that the inflexion point of the titration curve coincides with the theoretical equivalent point to better than 0.01%. (auth)

**32058** (GA-5978) UTILIZATION OF REACTOR FAST NEUTRONS FOR ACTIVATION ANALYSIS. Second Annual Report for the Period Ending November 30, 1964. Yule, H. P.; Lukens, H. R., Jr.; Guinn, V. P. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.). Dec. 14, 1964. Contract AT(04-3)-167. 90p. Dep.; $3.00(cy), 2(mn) (CFSTI).

The decay gamma-ray photopeak yields, and corresponding element detection limits, were calculated from the best available literature parameters for 896 nuclear reactions (thermal-neutron and fast-neutron). The reactor fast-neutron products of 71 elements were searched for experimentally (as were, for comparison, the thermal-neutron products of the same elements); wherever observed, the fast-neutron product yields were measured, experimental sensitivities were calculated from the results, and pulse-height spectra were obtained. Calculated yields were compared with experimental yields for 100 thermal-neutron $(n,\gamma)$ reactions and 46 reactor fast-neutron reactions [$(n,p)$, $(n,\alpha)$, $(n,2n)$, and $(n,n')$]. Reactor fast-neutron activation was found to be more sensitive than reactor thermal-neutron activation for the instrumental detection of eight elements (N, O, Si, P, Fe, Y, Tl, and Pb), and was found to be quite sensitive (sub-microgram quantities) for the detection of 24 additional elements (F, Mg, Al, S, K, Ti, Cr, Cu, Ni, Zn, Ge, Rb, Sr, Pd, Ag, Cd, Sb, Ba, Ce, Nd, Sm, W, Os, Hg). The efficiencies of thermal-neutron, epithermal-neutron and resonance-neutron shielding, for the suppression of $(n,\gamma)$ activation, were studied; the results showed that thermal-neutron shielding is easily accomplished, epithermal-neutron shielding is important but more difficult, resonance-neutron shielding is seldom important, and massive $^{10}B$ shielding is the best single means of suppressing $(n,\gamma)$ activation. It was found that reactor pulses produce enhancements of neutron-induced sensitivities for short-lived products: by factors of about 700 for activities with half lives of 0.1 sec, 70 for 1-sec half-life species, and 7 for 10-sec half-life species. A combination of reactor pulsing, multichannel scaling, and computer calculation was shown to provide much more precise and accurate half lives, for short-lived species, than the best currently available literature values. A least-squares computer program, including gain-shift correction, was shown to be a useful tool in the resolution of complex pulse-height spectra. (auth)

**32059** (IDO-14655) ANNUAL REPORT OF DIVISION ANALYTICAL BRANCH FOR 1964. Shank, Ralph C. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1965. Contract AT(10-1)-205. 212p. Dep.; $6.00(cy), 4(mn) CFSTI.

Improvements in various analytical methods are described. Mathematical solutions and instrument design for electrochemical processes are discussed, and a coulometric method for the determination of uranium is given. Various improvements in analytical equipment are described. Some of the analytical services which were provided for other branches and AEC contractors are described. Finally, some quality control data are tabulated. (D.L.C.)

**32060** (LF-22) ULTRAMICRO METHODS IN BIOCHEMISTRY. VII. THE DETERMINATION OF PLASMA OR SERUM UREA NITROGEN. VIII. THE DETERMINATION OF SERUM URIC ACID. IX. THE DETERMINATION OF SERUM CREATININE. van Stewart, E.; Longwell, Bernard B. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-2)-1013. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Ultramicro methods for the determination of serum urea nitrogen, uric acid, and creatinine were evaluated. The method for the determination of urea nitrogen is an ultramicro adaptation of the reaction in which a blue color is developed when the ammonium ion reacts with phenol and hypochlorite. Ammonia is released from urea with urease. The entire reaction is conducted on 5 μl of serum or plasma and the final volume of reaction mixture is 2.205 ml. The procedure for the determination of uric acid is an ultramicro adaptation of the method which depends on the reduction of phosphotungstic acid in the presence of bicarbonate. The phosphotungstic acid reagent contains lithium sulfate as a stabilizing reagent. The reaction is conducted on 100 μl of protein free solution prepared from 20 μl of serum by precipitation with tungstic acid. Comparative analyses show very good agreement between this method and the macro procedure from which it was derived. The creatinine method is an adaptation of a standard procedure utilizing the reaction with alkaline picrate. The reaction is carried out on 100 μl of protein-free solution obtained from 40 μl of serum by precipitation of the protein with tungstic acid. The results obtained with the method are in good agreement with values obtained using the macro procedure from which the ultramicro analysis was derived. Each analytical procedure was evaluated by determination of its reproducibility, and standard deviation analyses are presented. (auth)

**32061** (MLM-1247) LOW-LEVEL INTERNAL GAS PHASE PROPORTIONAL COUNTING OF KRYPTON-85 IN XENON. Wylie, K. F.; Hagee, G. R.; Ostensen, R. W. (Mound Lab., Miamisburg, Ohio). June 4, 1965. Contract AT(33-1)-Gen-53. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Methods for the routine measurement of trace amounts of krypton-85 in xenon were investigated in an effort to extend the limits of detection below $10^{-12}$ atom %. Internal

gas phase counters were used because of the high efficiency of this type of detector. The background counting rate was minimized by lead shielding and an anticoincidence ring. The proportional counting gas mixture which was found to give an acceptable counting plateau was 50% methane and 50% xenon. Standard krypton-in-xenon samples were prepared and used to calibrate the one-liter proportional counting chambers. In spite of high background counts the method was successful; standard samples of $2.18 \times 10^{-13}$, $3.17 \times 10^{-10}$, and $6.43 \times 10^{-9}$ atom % krypton-85 in xenon were determined within the 0.95 error of the counting rate on the plateau. (auth)

**32062** (ORO-593) A TECHNIQUE FOR THE RAPID ANALYSIS OF FALLOUT ACTIVITIES IN NATURAL WATERS. Final Report. Richter, Harold G.; Wright, Donald L. (Research Triangle Inst., Durham, N. C. Measurement and Controls Lab.). Mar. 31, 1965. Contract AT(40-1)-3070. 22p. (RTI-3070). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A technique for the analysis of fallout materials in natural waters was studied. The basis of the concentration step in this procedure is electrodeposition of the radioactive species from flowing systems. It was shown that electrodeposition from flowing systems can be achieved. Factors such as cell design, cell length, and electrode materials were examined, and a cell with a large ratio of electrode-area-to-liquid-volume was developed. The amalgam exchange process was studied as a rapid method for separation of species and found to be inadequate for such purposes in analysis procedures of this type. It is concluded that an array of spiral cathode cells can be used for the concentration step in analysis procedures. Until a satisfactory combination stripping and separation step is developed, a nonselective stripping agent should be used and the resulting concentrated fallout materials carried through a standard separation procedure. (auth)

**32063** (TID-7022(Vol.I)(Bk.4)) ANALYTICAL CHEMISTRY MANUAL OF THE FEED MATERIALS PRODUCTION CENTER. SAMPLES FROM THE SAMPLING PLANT: CANADIAN-DENISON (734) CONCENTRATE THROUGH CANADIAN-PRONTO (712) CONCENTRATE. (National Lead Co. of Ohio, Cincinnati). Dec. 1964. Contract AT(30-1)-1156. 372p. Dep.; $3.75(CFSTI).

A compilation is presented of wet chemical methods used to determine the chemical composition of uranium concentrates. (D.L.C.)

**32064** (TID-21942) OPTIMIZING NEUTRON ACTIVATION ANALYSIS. Leboeuf, M. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). [May 13, 1965]. Contract W-31-109-eng-52. 229. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The principal steps in activation analysis are outlined, and some guides are given for optimizing the use of this method for many analytical problems. The results attainable with this method are compared with those attainable by x-ray fluorescence. The computer processing of radioactivity data, using the AUGAR program, is discussed. (D.L.C.)

**32065** (UJV-1151/64) THE DETERMINATION OF LANTHANIDES IN URANIUM BY NEUTRON-ACTIVATION ANALYSIS. Vobecky, M.; Mastalka, A.; Marecek, J. (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). Feb. 1965. 15p. Dep.(mn).

The method of determining lanthanides in uranium using activation method of analysis is described. Having separated uranium on anion exchangers, the activation determination of the lanthanide oxides was then carried out. Final isolation of individual lanthanides was accomplished chromatographically on cation exchangers. After 20-hour irradiation in a nuclear reactor with a flux of $10^{13}$ neutrons $cm^{-2} - sec^{-1}$, $4 \times 10^{-12}$% of Dy, $10^{-10}$% of Eu, $4 \times 10^{-9}$% of Sm, and $1.5 \times 10^{-6}$% of La was determined in a target corresponding to 23.5 g of the original sample. The method described permits one to exploit fully the maximum sensitivity of the activation analysis. (auth)

**32066** A COMPARISON OF SEVERAL METHODS OF ASSAY OF CARBON-14 IN PROTEIN. Abell, C. W; Dirks, F. I; Delk, A. S.; Loeb, L. A. (National Cancer Inst., Bethesda, Md.). Anal. Biochem., 11: 170-5(May 1965).

Methods which are frequently used for the preparation and assay of carbon-14 labeled protein were evaluated. The results presented indicate that each technique has certain advantages and limitations which should be considered according to the design and purpose of the experiment. The plating of proteins on filter paper may be employed when sufficient material is available. The plating and washing of protein on Millipore filters is rapid, but the choice of solvents is limited. Preparations of insoluble radioactive protein may be conveniently counted by suspension in Cab-O-Sil. All weight ranges of protein samples studied may be assayed by digestion in Hyamine and determination in solution. (auth)

**32067** RECOVERY OF $S^{35}$ RADIOACTIVITY FROM PROTEIN-BEARING POLYACRYLAMIDE GEL. Young, Richard W.; Fulhorst, H. William (Univ. of California, Los Angeles). Anal. Biochem., 11: 389-91(May 1965).

A method is described for the recovery of $^{35}S$ radioactivity from protein-bearing polyacrylamide gel used in disk electrophoresis. The gel is dissolved in a few hours in 30% $H_2O_2$ and the entire volume of solution counted. Results are reported from studies of the recovery of radioactivity from $^{35}S$-albumin in serum aliquots from mice injected with $^{35}S$-L-methionine. (C.H.)

**32068** LIQUID SCINTILLATION COUNTING OF RADIOIODINE. Rhodes, Buck A. (Johns Hopkins School of Hygiene and Public Health, Baltimore). Anal. Chem., 37: 995-7(July 1965).

Eight liquid scintillation systems were evaluated for counting radioiodide. The balanced quenching technique was adapted to the measurement of $^{125}I$. Moderately quenched (14 to 42% quenched) $^{125}I$ solutions may be directly counted with a uniform efficiency of 28.6%. The counting efficiency of $^{125}I$ was greatly increased compared to previous reports. A maximum efficiency of 56% was found. Two peaks of the $^{125}I$ spectra can be distinguished in the liquid scintillation system used. (auth)

**32069** DETERMINATION OF MICRO AMOUNTS OF TANTALUM IN NIOBIUM BY USING NEUTRON ACTIVATION AND GAMMA SPECTROMETRY. Dugain, Francois (Pechiney Cie., L.R.M., Grenoble, France); Laverlochere, Jean. Anal. Chem., 37: 998-1000(July 1965).

A method was developed for the routine determination of tantalum in niobium and niobium oxide. The neutron activation method has the advantage of being extremely sensitive and selective, because of the very different characteristics of the two radioisotopes produced: $^{94}Nb$ and $^{182}Ta$. The main effort was centered on the interferences that arise in the case of $^{182}Ta$, the radiochemical separation processes, which would avoid these interferences, the limits of destructive and nondestructive methods, and the accuracy obtained. The sensitivity was excellent, even for an irradiation of only 1 hour in a flux of $10^{12}$ n/cm$^2$ sec. (auth)

**32070** A STUDY OF SPECTROCHEMICAL DETECTION LIMITS OF SELECTED ELEMENTS IN TUNGSTEN. Dyck, Rudolph (Sylvania Electric Products, Inc., Towanda, Penna.). Anal. Chem., 37: 1046-9(July 1965).

Standards of tungsten powder were diluted with graphite in the ratio of 1.0 g of tungsten to 200 mg of SP-2 graphite, and with high-purity zinc oxide in the same ratio. The criterion for detection limits was arbitrarily chosen to be a line intensity at least 10% transmittance units darker than the background, which was held within the range of 90 to 95% transmittance. Moving plate studies were carried out in the conventional manner using intensities of selected arc lines at 15-sec consecutive intervals. The marked difference in detection limits was the most significant advantage gained from adding graphite before arcing. It enabled good detection limits to be achieved for those elements whose main lines were interfered with by tungsten. (F.J.H.)

**32071** POLAROGRAPHIC DETERMINATION OF LEAD IN AMERICIUM DIOXIDE WITH HYDROXYLAMINE HYDROCHLORIDE AS SUPPORTING ELECTROLYTE. Plock, C. E. (Dow Chemical Co., Golden, Colo.). Anal. Chem., 37: 1056-7(July 1965).

All polarograms of lead in americium dioxide were obtained using a calibrated recording polarograph. For analysis of solutions of low lead concentrations (0.003 to 0.100 mM), a micro range extender was used as an accessory. Because of the toxicity of americium, extreme care had to be exercised in its handling. Samples of $AmO_2$, 100 to 150 mg, were weighed directly into a tared volumetric flask (25 or 50 ml). Ten ml of 6M and 3 ml of 8M $HNO_3$ were added and the mixture was heated to almost dryness. The residue was dissolved in 0.3M HCl. Sufficient 5M $NH_2OH \cdot HCl$ and 0.2% gelatin were added to make their concentration in the final solution 0.5M and 0.01%, respectively. A plot of EDE vs the log (i/id-i) for the standard lead solutions produced a straight line with a slope equal to 0.031 volt. This experimental value was in good agreement with the theoretical value of 0.03 volt for the reduction of a divalent metal ion. The half-wave potential determined for the reduction of $Ph^{2+}$ to $Pb^0$ was $-0.448 \pm 0.004$ volt vs SCE. A half-wave potential of $-0.46$ volt vs SCE was reported for the reduction of divalent lead in 2M $NH_2OH \cdot HCl$. (F.J.H.)

**32072** 14-Mev NEUTRON ACTIVATION ANALYSIS OF RARE EARTH ELEMENTS IN ORES AND MINERALS. Menon, M. P.; Cuypers, M. Y. (Agricultural and Mechanical Univ., College Station, Tex.). Anal. Chem., 37: 1057-9(July 1965).

A large number of minerals obtained from different sources were analyzed for cerium, praseodymium, and yttrium. Nuclear reactions, which were used for the measurement of the elements were $^{140}Ce(n,2n)^{139m}Ce$, $^{141}Pr(n,2n)^{140}Pr$, and $^{89}Y(n,n')^{89m}Y$, respectively. $^{139m}Ce$ and $^{89m}Y$ emitted gamma rays with respective energies of 0.74 and 0.91 Mev, while $^{140}Pr$ emitted positrons whose 0.511 Mev annihilation radiation was detectable. A 150-kv Cockcroft-Walton accelerator, which generated 14-Mev neutrons by the $^2H(^3H,n)^4He$ reaction was used for activating the samples. The neutron dose to which each sample and every standard was exposed was measured using a $BF_3$ neutron detector tube connected to an RIDL scaler. (F.J.H.)

**32073** ESTIMATION OF ANTIMONY IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Howie, R. A.; Molokhia, M. M.; Smith, Hamilton (Glasgow Univ.). Anal. Chem., 37: 1059-61(July 1965).

Samples of high-purity antimony potassium tartrate and of biological materials were weighed into a silica tube, which was then sealed. The samples and standard were packed in a standard aluminum can and irradiated for three days at a thermal neutron flux of $10^{12}n/cm^2/sec$. The antimony on digestion with acid was processed through a series of precipitations with reagents. This separation scheme gives chemical recoveries of 70% of the antimony originally present. These were determined by tracer experiments. Similar experiments were made to show the satisfactory elimination of interfering elements. The radiochemical purity of the final precipitate was demonstrated by $\gamma$-scintillation spectrometry and half lives. The separation does not remove bismuth, but bismuth activated by neutron capture to give $^{210}Bi$ will give only 0.3% of the activity of an equal amount of antimony activated to give $^{122}Sb$. Trials on solutions containing $10^{-10}$ to $10^{-8}$g of antimony under standard irradiation and processing conditions gave results, which agreed with the calculated value within 5%. (F.J.H.)

**32074** ION EXCHANGE SEPARATION AND VOLUMETRIC DETERMINATION OF GALLIUM IN PLUTONIUM-GALLIUM ALLOYS. Miner, F. J.; DeGrazio, R. P. (Dow Chemical Co., Golden, Colo.). Anal. Chem., 37: 1071-2 (July 1965).

The separation of gallium and plutonium by ion exchange was based on the difference in the types of complex ions formed by the two elements. Investigations of the hydrochloric acid system indicated no comparable problems and a successful quantitative separation procedure was developed. A weighed alloy sample was dissolved in hydrochloric acid and the sample solution was eluted through an anion exchange resin column. After completely removing the plutonium, the eluate was changed and the gallium was quantitatively removed and determined. Volumetric determination of gallium was based on EDTA titration. The reaction between gallium and EDTA is relatively slow. The xylenol orange-thorium system gave the best visual color change at the end point. The titration was carried out in a weak acid solution, primarily to prevent hydrolysis of gallium. The more acidic the solution, the less interference there was from cationic impurties. (F.J.H.)

**32075** SPECTROPHOTOMETRIC DETERMINATION OF Ce(IV). Papafil, M.; Furnica, M.; Furnica, D. (Universite "Al. I. Cuza," Romania'. Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 131-4(1964). (In French)

A spectrophotometric method for the determination of Ce(IV), based on the reaction between o-phenylenediamine and ions of cerium in acid media, was proposed. The optimum conditions for the determination were established. The minimum concentration that could be determined was 0.86 $\gamma$ Ce/ml. The effects of some metals were investigated and the ratio Me/Ce at which the determination can not be carried out was established. Ions with variable valences, such as Fe(III) and Tl(III), interfered with the reaction. (tr-auth)

**32076** RADIOPOLAROGRAPHY OF THE PEAK FORMED IN ARSENIC REDUCTION, CATALYZED BY COBALT(II) OR IRON(II). Ralea, Radu; Cecal, Alexandru. Analele Stiint. Univ. "A. I. Cuza." Iasi, Sect. I, 10: 135-8(1964). (In French)

The polarographic reduction of As in a given medium, containing small quantities of Co or Fe that are absolutely necessary, gives one analytically useable peak. The nature of this peak was investigated by the polarographic method, using the radioisotopes $^{76}As$, $^{60}Co$, and $^{55,59}Fe$. The velocity of the precipitation was investigated by measurement of the activity of a mercury drop flowing in a given time, at 50 mv. Arsenic can be identified under these conditions by the peak because the potentials of the three elements are superposed. (tr-auth)

**32077** POLAROGRAPHIC DETERMINATION OF THORIUM IN BUFFERED- AND BUFFER-FREE MEDIA. Ralea, Radu; Bosnea, Lucie (Universite "Al. I. Cuza," Romania). Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 139-44(1964). (In French)

The behavior of thorium on the mercury drop electrode was examined. The effect of various indifferent electrolytes in buffered and non-buffered media was investigated. The half-wave potential had a negative value under the effects of different anions of electrolytes in the order $NO_3^- < Cl^- < SO_4^{2-} < HCOO^-$. This was explained as resulting from the formation of compounds with thorium. Increased organic solvent negated the potential half-wave, in which case complexes with thorium were formed. Buffered media affected the wave and its potential. With reduced concentration of the buffer and increased concentration of the electrolytes separate waves appeared. In the case of dissolved oxygen, the reduction slopes of oxygen were formed instead of the thorium reduction slopes. Variation in the height of the mercury reservoir produced a doubling of the plateau toward more negative potentials. The doubling could also be obtained by variation of the thorium concentration in the different electrolytes. It was concluded that the slopes produced by the depolarizing action of thorium can be caused by the catalytic reduction of hydrogen ions. (J.S.R.)

**32078** DETECTION OF SILVER CONTENTS IN FILM USING ISOTOPIC X-RAYS. Furuta, Junichiro; Hiraoka, Eiichi (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 78-9(Mar. 1965).

The x rays from a $^{147}Pm$-antimony oxide source show a sharp peak at 26 kev and are strongly absorbed by silver. The silver contents in x-ray films of various photodensities were measured using this x-ray source. The completely

dark film absorbed 5% of the incident x rays, which corresponded to 1.2 mg/cm$^2$ of silver. (auth)

**32079** CONVENIENT PREPARATION OF STANDARD NIOBIUM SOLUTION. Nordling, W. D. (Grinnel Co., Providence). Chemist Analyst, 53: 13-14(1964).

Potassium niobate is dissolved in 4% oxalic acid solution. The Nb content of this solution can be established by precipitation using cupferron and ignition to the oxide. This standard is suitable for photometric determinations by the quinol method. (Anal. Abstr., 12: No. 4(Apr. 1965))

**32080** AN IMPROVED METHOD FOR DETERMINING CALCIUM-45 IN BIOLOGICAL MATERIALS. Humphreys, E. R. (Royal Free Hospital School of Medicine, London). Intern. J. Appl. Radiation Isotopes, 16: 345-8(June 1965).

A method was developed to determine $^{45}$Ca activity in biological materials. It consists in precipitating calcium oxalate from solution and converting it to calcium perchlorate by a two-stage incineration process with 60% perchloric acid. The calcium perchlorate is dissolved in a mixture of 20% tributyl phosphate in toluene containing 0.3% PPO (25-diphenyloxazole) and counted directly in a scintillation counter. (auth)

**32081** USE OF A LIQUID SCINTILLATION SPECTROMETER FOR THE DIRECT MEASUREMENT OF THE RADIOACTIVITY OF TRITIUM INCORPORATED IN THE CELLS OF MAMMALS CULTIVATED IN VITRO. Fallot, P. (Centre d'Etudes Nucleaires, Saclay, France); Girgis, A.; Laine-Boeszoermenyi, M.; Vieuchange, J. Intern. J. Appl. Radiation Isotopes, 16: 349-56(June 1965). (In French)

A technique is described for the direct measurement of the radioactivity of tritium incorporated in the cells of mammals, cultivated in vitro and fixed on cover slips. The radioactivity of each cover slip is measured by a liquid scintillation spectrometer, after immersion in the vial containing the scintillator solution. This method was compared with autoradiography carried out on the same sample. In order to establish the efficiency of this direct measurement the authors developed a microcombustion technique, applied to the cells fixed on a single coverslip. Measurement of the tritiated water formed gives the number of disintegrations in each sample. Comparisons of the results show a satisfactory agreement between the count number obtained by direct measurement, the autoradiographic blackening, and the number of disintegrations measured after combustion. The direct measurement technique is simple, quick and accurate, and provides a useful complement to the autoradiographic method. (auth)

**32082** THE DETERMINATION OF MANGANESE IN URINE BY NEUTRON ACTIVATION ANALYSIS. Moav, B. (Atomic Energy Commission, Yavne, Israel). Intern. J. Appl. Radiation Isotopes, 16: 365-9(June 1965).

A rapid and simple method for the determination of manganese in urine using neutron activation analysis is described. The procedure consists of radiochemical separation followed by measurement of the radioactivity induced in manganese by multichannel pulse-height analyses. The excretion of manganese in urine of normal human subjects was found to range from 7.7 to 17.6 μg for a 24-hr period. After administration of EDTA, excretion of manganese was significantly higher. (auth)

**32083** COUNTING ERRORS IN RADIOACTIVITY MEASUREMENTS BY THE EFFICIENCY TRACING TECHNIQUE. Kawada, Y. (Electrotechnical Lab., Tokyo). Intern. J. Appl. Radiation Isotopes, 16: 371-5 (June 1965).

The statistical nature of the results of radioactivity measurements made by the efficiency tracing technique using a short-lived tracer or a long-lived tracer is discussed from the standpoint of a random-sampling survey theory, and equations are given for the fractional standard deviation of each tracing plot and for the most suitable mixing ratio of the activities of the tracer to those of the β-emitter. Some of these remarks can be applied to the derivation of an expression for the counting error in the activity measurements of the β−γ coincidence-counting method. (auth)

**32084** PARTITION CHROMATOGRAPHY OF RARE EARTHS WITH DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID. IV. DETERMINATION OF MICROAMOUNTS OF HOLMIUM IN DYSPROSIUM AND OF LUTETIUM IN YTTERBIUM BY ACTIVATION ANALYSIS. Grosse-Ruyken, H.; Bosholm, J. (Technische Universitaet, Dresden). Kernenergie, 8: 224-6(Apr. 1965). (In German)

Using partition chromatography with di-(2-ethylhexyl)-phosphoric acid, the bulk of rare-earths samples were depleted by a factor of $10^4$ before neutron activation. Consequently, the sensitivity of determination of holmium in dysprosium and of lutetium in ytterbium will rise by the same factor. Thus, holmium and lutetium contents of $(1-5) \times 10^{-3}$ percent were determined with a standard variation of ±15 percent. (auth)

**32085** NEUTRON-ABSORPTION DETERMINATION OF BORON IN ORES. Ostroumov, G. V.; Bulatov, F. A.; Zaitsev, E. A. Metody Khim. Analiza Mineraln. Syrya, Vses. Nauchn.-Issled. Inst. Mineraln. Syrya, 7: 25-30 (1963).

This method is based on the strong absorption of thermal neutrons by $^{10}$B; it involves use of ⩽30 g samples (particle size ⩾0.2 mm), with a Po–Be source (20 to 30 mC in Po). The relative error is ±10%. Iron, H, and Cl interfere, but this interference can be avoided by using comparison standards of composition corresponding to the average of the ores being analysed. The effect of H, which scatters the neutrons, is diminished by carrying out the measurements on 'thin layers' (samples of 1 g). The effect of Cl can also be avoided by extracting the Cl from the sample with $H_2O$ (B is only slightly extracted). (Anal. Abstr., 12: No. 4(Apr. 1965))

**32086** USE OF ALUMINON FOR THE COLORIMETRIC DETERMINATION OF BERYLLIUM. Morgen, E. A.; Anisimova, E. A. Nauchn. Tr., Irkutskii Gos. Nauchn.-Issled. Inst. Redkikh Metal., 11: 61-6(1963).

The color of the 1:1 complex of Be with aluminon (I) is maximum after boiling a solution of pH 5.3 to 5.7 for 1 min; the maximum absorption of the complex is at 536 mμ (there is negligible absorption by aluminon at this wavelength). Beer's law is obeyed for 0.1 to 1.4 μg of Be per ml. Gelatin is added to the solution to prevent coagulation of the lake. Interference due to Ca, Fe, Al, and Cu is avoided by addition of EDTA. Under these conditions, Al (⩾30), $Fe^{3+}$ (⩾20), and Cu or Ca (⩾60 μg per ml) do not interfere in the determination of 0.6 μg of Be per ml. The concentration of EDTA should be constant, and any large excess should be avoided, as it reacts with aluminon. Alkali metals considerably increase the absorption of the Be–aluminon complex, but ⩾15 μg of Na per ml does not interfere. To determine Be in alkaline solutions titrate 2 to 5 ml of solution (5 to 7 μg of Be) with dilute acetic acid, add excess of the acid (to pH 5.4), then 1 ml of 3% EDTA, 10 ml of 0.05% aluminon, and 5 ml of 0.5% gelatin solution, boil for 1 min, cool, dilute to 50 ml, and measure the extinction with a green filter. The mean square error of the determination is 0.63%, and the method is sensitive to 0.05 μg of Be per ml. (Anal. Abstr., 12: No. 4(Apr. 1965))

**32087** ACTIVATION ANALYSIS READY FOR ROUTINE USE. Glos, Margaret Beach. Nucleonics, 23: No. 6, 62-6; 68-70(June 1965).

A survey of developments in methods and instrumentation for activation analysis is presented, covering associated radiochemistry, biological standards, and the use of charged particles, secondary reactions, computers, and semiconductor detectors. Information presented at a seminar in San Diego on clinical, forensic, and industrial applications of activation analysis is summarized. (D.C.W.)

**32088** ISOTOPIC ASSAY OF BORON-10 IN BORON TRIFLUORIDE BY MOLECULAR SPECTROSCOPIC METHOD. Krishnamachari, S. L. N. G.; Vengsarkar,

B. R. (Atomic Energy Establishment, Trombay, India). Proc. Indian Acad. Sci., Sect. A, 61: 172-6(Mar. 1965).

A molecular spectroscopic method was developed to estimate the $^{10}B$ concentration in $BF_3$. This method makes use of the isotopic displacements in the $R_1$ heads of the $BO_2$ band at 5457 Å. The emission spectrum of the $BO_2$ radical was obtained in a microwave oscillator discharge through $BF_3$ and an excess of argon, having oxygen as trace impurity. The intensities of the $R_1$ heads were measured for different standards containing 20 to 90 per cent of $^{10}B$ in $BF_3$. The standard deviation varies from 1.7 to 2.7 in the above concentration range. (auth)

**32089** TRITIUM AND PHOSPHORUS-32 IN HIGH-RESOLUTION AUTORADIOGRAPHY. Caro, Lucien G.; Schnoes, Maria (Oak Ridge National Lab., Tenn.). Science, 149: 60-2(July 2, 1965).

The sensitivity of monolayers of Ilford L-4 nuclear emulsion for $\beta$-particles is approximately 0.20 grain per particle emitted for $^3H$, and 0.025 grain per particle for $^{32}P$. The sensitivity for thick layers is 1.3 grains per tritium $\beta$-particle emitted within the emulsion. In electron microscopic autoradiographs the maximum resolution is approximately 0.1 micron for $^3H$ and 0.3 micron for $^{32}P$. (auth)

**32090** MASS SPECTROMETER SYSTEMS FOR ISOTOPE GEOCHEMISTRY. I. HIGH SENSITIVITY MASS SPECTROMETRY OF RARE GASES BY A SYSTEM WITH A GETTER ION PUMP. Sakai, Hitoshi (Okayama Univ., Japan); Nakatani, Tadao. Shitsuryo Bunseki, 12: 183-94 (Mar. 1965).

A 20-cm, 90° direction focussing mass spectrometer was constructed for laboratory use in isotope geochemistry. The mass spectrometer is of conventional design but has a greater flexibility for future modifications. For obtaining high vacuum of better quality and for its easy maintenance, a 40 l/sec getter ion pump was employed in the main pumping system together with a chemisorption pump. Without using an oil diffusion pump, vacuum of better than $10^{-8}$ mm Hg was easily obtained, although argon background was always high as expected. The absolute amount of the residual argon in the analyzer tube was found to range from 1 to $10 \times 10^{-7}$ ml STP. The mass spectrometer was used for the high sensitivity mass spectrometry of rare gases using a six-stage secondary electron multiplier. It was demonstrated that the system has enough sensitivity to measure $10^{-9}$ ml STP xenon. The residual gases in the analyzer up to xenon mass regions were also analyzed. (auth)

**32091** MASS SPECTROGRAPHY FOR THE ANALYSIS OF SOLIDS. II. DETERMINATION OF ISOTOPIC RATIOS OF LEAD, THORIUM, AND URANIUM IN MINERALS. Makita, Tutomu; Nishiyama, Shingo (Kyoto Univ.). Shitsuryo Bunseki, 12: 223-8(Mar. 1965). (In Japanese)

The isotopic ratios of lead, thorium, and uranium in minerals were determined by vacuum spark mass spectrography. The facts that no chemical separations were necessary, that size of minerals for analysis was very small, and that the isotopes of interest were examined in situ were advantages of this procedure. Preliminary dating by $^{207}Pb/^{206}Pb$, $^{238}U/^{206}Pb$, $^{235}U/^{207}Pb$, and $^{232}Th/^{208}Pb$ by this method agreed well. The sources of discrepancies were discussed. (auth)

**32092** OSCILLOGRAPHIC METHOD FOR A RAPID QUANTITATIVE ANALYSIS OF HIGH-TEMPERATURE MATERIALS. Gokhshtein, Ya. P. (Scientific Research Inst. of High Temperatures, USSR). Teplofiz. Vysokikh Temp., 3: 238-43(Mar.-Apr. 1965). (In Russian)

An oscillographic method is described that makes possible the quantitative determination of Nb in excess Zr and of Ti in the presence of significant quantities of Nb and Zr. The method does not require preliminary separation of the specified elements. The investigations were carried out on the oscillographic polarograph OP-1-61. (tr-auth)

**32093** DETERMINATION OF $^3H$ AND $^{14}C$ IN BLOOD. Houtman, A. C. (N. V. Philips-Duphar, Isotope Research Lab., Amsterdam). p.297-301 of "EUR-2200.e."

The radiochemical determination of very small amounts of $^3H$ or $^{14}C$ in blood samples is discussed. Emphasis is placed on the preparation of samples for scintillation counting. (C.H.)

**32094** A CONVENIENT METHOD FOR THE DETERMINATION OF METABOLICALLY LIBERATED $C^{14}O_2$. Roberts, Eugene; Simonsen, Daisy G.; Sisken, Betty (City of Hope Medical Center, Duarte, Calif.). p.93-6 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

The method developed by Albers by which small amounts of $^{14}CO_2$ liberated by enzymes from L-glutamic acid-$^{14}C$ were trapped in Hyamine base and counted in a liquid scintillation counter was modified so that the $^{14}CO_2$ was trapped in the Hyamine base contained in a regulation size counting vial, which could be counted under standard conditions without any additional pipetting. (M.C.G.)

**32095** SOME TECHNIQUES OF RADIOACTIVE GAS CHROMATOGRAPHY FOR LIPID RESEARCH. Dutton, H. J. (Dept. of Agriculture, Peoria, Ill.). p.123-34 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

Modifications of gas-chromatographic techniques to meet problems encountered with high-boiling, radioactive lipid compounds are discussed. Ion-chamber monitoring of the effluent stream from gas-chromatographic columns, uses of scintillation solvents, and the microvapor-phase hydrogenation technique are described. (M.C.G.)

**32096** SCINTILLATION MEASUREMENT OF LOW-ENERGY PHOTONS. Jackson, B. J. (Atomic Energy of Canada Ltd., Ottawa). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/13, 18p. (CONF-650507-13)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

A low-cost system suitable for several low-energy gamma-emitting isotopes, such as $^{145}Sm$, $^{153}Gd$, $^{159}Dy$, $^{109}Cd$, $^{119}Sn$, $^{123}Te$, and others that incorporates a ratio detector as a spectrum stabilizer and permits accurate counting of the low-energy photons in spite of P.M.T. gain fluctuations is described. This system was used very successfully on iodine-125. The photon energy in this case is mainly 27.4 kev and the gain of the amplifier following the P.M.T. was adjusted to give approximately thirty volt pulses at its output and the peak spread over approximately thirty volts. A two-channel analyzer was set with one channel on the lower-energy half of the peak, the other channel on the upper-energy half. Each channel output went into the ratio detector which indicated if the ratio was high, low, or 1:1. Any change in the over-all gain was compensated for by adjusting the amplifier fine gain until the ratio returned to 1:1. The count rate, measured with a scaler, was related to the activity in an absolutely standardized sample. The photon absorption in the sample must be reproducible. For the iodine-125 example quoted, sample activity was in the region of one microcurie, but much lower activities may be determined with longer counting times and attention to background reduction. (auth)

**32097** A SIMPLIFIED APPARATUS FOR COLLECTING $^{14}CO_2$ FOR LIQUID SCINTILLATION COUNTING. Miras, C. J.; Mautzos, J. D.; Levis, G. M. (Univ. of Athens). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/10, 6p. (CONF-650507-30)

The IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The use of an apparatus suitable for enzymatic or chemical reactions during which $^{14}CO_2$ is liberated and has to be trapped for subsequent liquid scintillation counting is described. The apparatus consists of a screw-capped McCartney bottle in the inside of which is hung a small absorption vessel. After absorption of $CO_2$ in hyamine solution the vessel is transferred in toto into a counting vial containing

scintillation solution for subsequent counting. Results from experiments in which $^{14}Co_2$ was collected for different time periods and with the absorption vessel at different heights from the surface of the reactions mixture showed that quantitative absorption of $CO_2$ was achieved within 30 minutes, regardless of the height at which the absorption vessel was hung. Besides being cheap and easy to construct the described apparatus has the advantages of the short time needed for quantitative absorption of $CO_2$ and the possibility of hanging the absorption vessel at different heights so that contamination from frothing reaction procedures is avoided. The apparatus was successfully used for chemical and enzymatic decarboxylation of $^{14}C$-labeled long chain fatty acids. (auth)

**32098** THE ASSAY OF ALPHA AND BETA EMITTERS USING SCINTILLATING ION EXCHANGE RESIN. Heimbuch, A. H.; Gee, H. Y.; De Haan, A.; Leventhal, L. (Tracerlab, Richmond, Calif.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/56, 20p. (CONF-650507-24)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The development of Scintillating Ion Exchange Resins (SIER) has provided a unique system for the detection and counting of alpha and beta emitting nuclides. Both anionic and cationic SIER were developed and possess the strongly basic, quaternary ammonium group and the strongly acidic, aryl sulfonic group, respectively. The stability of SIER is such that it can be used in solution of strong sodium hydroxide, concentrated hydrochloric and sulfuric acids, as well as 6N nitric acid at 25°C for short periods (3 to 4 hrs) of time. SIER is readily adapted for counting using the available scintillation counting apparatus. SIER in the form of small spherical beads permits the use of counting vessels with many different geometric configurations. Both alpha and beta emitting nuclides were efficiently adsorbed and counted using these methods. The low energy beta emitters such as $^{63}Ni$ and $^{14}C$ were counted with 12 and 35% efficiencies, respectively. The alpha emitters of $^{239}Pu$ and $^{237}Np$ were adsorbed and efficiently counted (70–90%) on both the anionic and cationic resins. $^{14}C$-tagged amino acids were also counted at over 20% efficiency using a liquid scintillation counter. Many of the problems of sample quenching and incompatibility in liquid scintillation counting can be circumvented by the use of SIER. (P.C.H.)

**32099** QUANTITATIVE RADIOASSAY METHODS FOR THIN-LAYER CHROMATOGRAPHY. Snyder, F. (Oak Ridge Inst. of Nuclear Studies, Tenn.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/70, 17p. (CONF-650507-25)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Photodensitometric scans of autoradiographic lanes from thin-layer chromatograms (TLC) were made and compared to zonal scans for sensitivity and resolution. Photodensitometric analysis of autoradiograms, requires less expensive equipment to obtain the radioactive distribution curves, but has the disadvantages of being more time consuming and of providing poorer resolution than the zonal scans. Krylon is sprayed on the chromatogram to maintain the integrity of the adsorbent when in contact with the film. Autoradiograms of TLC plates are then prepared using Kodak no-screen x-ray film placed in contact with the chromatograms in a special box designed for this purpose. After a proper period of exposure (a guide table for $^{14}C$, $^{3}H$ and $^{32}P$ exposures will be shown) the film is developed in the usual manner with Kodak developer and fixer. The density along chromatographic lanes of the developed film is measured from 1 cm below the origin to 1 cm above the solvent front with a Photovolt densitometer. The automatic recording of the film density is evaluated by area analysis. (P.C.H.)

**32100** MEASUREMENT OF COLLOIDAL $Au^{198}$ AND $P^{32}$ PRESENT IN THE SAME SAMPLE. Cohen, Y.; Ingrand, J.; Rousselet, J. P. (Centre d'Etudes Nucleaires, Saclay, France and Faculte de Pharmacie, Paris). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/59, 19p. (In French). (CONF-650507-22)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Two methods were studied for determining $^{198}Au$ and $^{32}P$ in the same sample. The first method consisted of measurement of the $^{198}Au$ and $^{32}P$ after establishing their respective electromagnetic spectral curves and selecting favorable peaks. The second is simultaneous radioactivity measurements using a photomultiplier with two distinct amplitude discrimination thresholds which give different yields for the two emissions. Both methods were evaluated with the help of standards, their validity is discussed, and the limits of their applicability are specified. The second method was employed in studying the reciprocal effects of colloidal $^{198}Au$ and $^{32}P$ on in vitro sedimentation in an ascitic fluid. (P.C.H.)

**32101** DETERMINATION OF FALLOUT RADIONUCLIDES IN ENVIRONMENTAL SAMPLES BY GAMMA-RAY SPECTROMETRY. Ward, G. M.; Johnson, J. E.; Wilson, D. W. (Colorado State Univ., Fort Collins). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/45, 13p. (CONF-650507-26). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

From May 1962 to date many environmental samples were collected from the University farm to study the passage of $^{137}Cs$ through an important part of man's food chain. All samples were of low specific activity and determinations were made in a low level gamma spectrometer system consisting of an 8 in. diameter, 4 in. thick NaI(Tl) crystal that was shielded from background by a 5 in. thick steel-walled chamber and connected to a 400 channel pulse height analyzer. Air filter pads and large samples (1 kg) of dried forage, grains, and bovine feces were counted directly in a constant geometry. Precipitation samples were concentrated by passing through Dowex-50 cation exchange columns. Milk, meat, and urine were counted in large annular lucite containers. $^{137}Cs$, $^{40}K$, $^{131}I$, $Ba-^{140}La$ were the only gamma-ray emitting radionuclides found in milk, meat, and urine since these were the only fission products absorbed in appreciable amounts. In addition, the other samples contained $^{141,144}Ce$, $^{125}Sb$, $^{103,106}Ru$, $Zr-^{95}Nb$, and $^{54}Mn$. In these samples, which were collected in 1962 and 1963, only $Zr-^{95}Nb$, because of its relative abundance, could be determined reliably by gamma spectrometry during a period of about 6 months after collection. Photopeaks of $^{137}Cs$, $^{54}Mn$, and $^{125}Sb$ were completely obscured and lower energy nuclides ($^{141,144}Ce$ and $^{103}Ru$) had large compton contributions from higher energy nuclides. Spectrum stripping is not reliable if the photopeaks are not apparent. Data are tabulated. (P.C.H.)

**32102** ION EXCHANGE SEPARATION OF CALCIUM AND STRONTIUM APPLICATION TO DETERMINATION OF STRONTIUM-90 IN MILK. Senvar, C. B.; Ergin, M.; Usul, F. (Univ. of Ankara). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/20, 10p. (CONF-650507-29). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

An ion exchange technique was used for the successful separation of calcium and strontium in milk ash. Initially the operation was carried out using an artificial solution having approximately the same amount of calcium and strontium present in 5 g of milk ash. This solution was spiked with $^{45}Ca$ and $^{90}Sr$. The known milk ash sample was also spiked to provide a control. Milk ash was dissolved in nitric acid and the alkaline earth elements were precipitated in their carbonate form which in turn were dissolved in hydrochloric acid and passed through a column of Zeo-Carb 225 × 8, 200 mesh at pH = 2.5. Strontium elution with HCl was tried and found to be more effective and convenient than ammonium lactate. Strontium yields were satisfactory and agreement between the ion exchange method developed

and the method of fuming nitric acid was good. The ion exchange technique avoids many of the difficulties of the conventional method of fuming nitric acid. The amount of work and chemicals required is considerably reduced in the new procedure. (P.C.H.)

**32103** THE ACTIVATION ANALYSIS OF SODIUM AND POTASSIUM IN THE BIOLOGICAL MATERIAL. Hori, R. (Toyama Univ., Japan). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/29, 7p. (CONF-650507-10). ORINS.

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The sodium and potassium content in the egg of the sea urchin Hemicentrotus pulcherrimus was estimated by activation analysis. The eggs without jelly were washed five times in an isotonic solution of urea or glucose following Sugiyama's procedures. They were then centrifuged and dried at 100–110°C. The dried material was ashed (390–400°C) and less than one-thousandth volume of the ash necessary for the flame-photometric analysis was activated in JRR-1 reactor (neutron flux: $3 \times 10^{11}$ n/cm$^2$ sec, 1-2 hrs). $^{24}$Na and $^{42}$K produced in the irradiated sample were separated using a cation exchanger. The amount of both ions was determined by comparing the gamma spectrograms of the radioisotopes obtained by a multichannel analyzer with those of the standard sample. In the unfertilized eggs the concentration of sodium is very low, being approximately ten percent of potassium. When the eggs are fertilized, both ions increase. The increasing rate of sodium is more remarkable than that of potassium. (P.C.H.)

**32104** MULTIDIMENSIONAL GAMMA RAY SPECTROMETRY AND ITS USE IN BIOLOGY. Nielsen, J. M.; Kornberg, H. A. (Battelle Memorial Inst., Richland, Wash.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/21, 16p. (CONF-650507-12)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Multidimensional gamma spectrometry is a new technique for the measurement of radionuclides which has special application in biology. This instrumental technique allows direct identification and measurement of individual gamma emitters in complex mixtures of radionuclides in diverse sample matrices without prior chemical treatment. The detector system is designed to provide: high sensitivity through use of two large (6 inch diameter, 4 inch thick) NaI (Tl) detectors; high selectivity by using coincidence counting techniques that separate gamma spectra by taking advantage of the gamma decay characteristics of each radionuclide; and ultra low background and reduced Compton interference through a surrounding anticoincidence annulus detector (a NaI (Tl) crystal 11½ inches thick with a 6½ inch diameter hole). A 4096 channel multidimensional analyzer analyses the two gamma rays in coincidence according to their energies and stores them in the plane of the 64 × 64 channel memory while non-coincident events are stored only on the axes of the memory. This effectively decreases the background and Compton interference by orders of magnitude while greatly improving the selectivity. Direct gamma spectrometric measurement of trace levels of radionuclides in biological samples has been inhibited by the presence of relatively large amounts of natural $^{40}$K whose 1.47 Mev gamma radiation has interfered with their measurement. Since most radionuclides decay through emission of two or more gamma rays in cascade the new technique does provide a direct selective measurement and permits wider application. This technique could be applied to studies where tracers are added and would be especially useful for the simultaneous measurement of absorption, deposition, and turnover in the animal body of several suitably labeled compounds. When used with neutron activation analysis measurements of a large group of elements may be made in tissues and blood at the parts-per-billion level. (auth)

**32105** PRECISE MEASUREMENTS OF THE ACTIVITY OF LOW BETA EMITTERS USING CALIBRATED IONIZATION CHAMBERS. Williams, A. (National Physical Lab., Teddington, Middx, Eng.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/3, 12p. (CONF-650507-9)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Several methods of improving the accuracy of measurements with low energy beta emitters have been tried at the U.K. National Physical Laboratory and some of these are described. Calibrating the ionization chamber is also a difficult problem for these nuclides, due to the self-absorption in the sources used for determining the absolute value of the activity. The efficiency tracer technique is widely used to overcome this difficulty and some of the recent developments of this method are given and the accuracy obtainable by this method is discussed. (P.C.H.)

**32106** AUTORADIOGRAPHY OF SECTIONED SOIL CORES. Held, E. E.; Gessel, S. P.; Matson, L. J.; Billings, R. F. (Univ. of Washington, Seattle). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/37, 13p. (CONF-650507-6)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Techniques for identifying specific radionuclides associated with specific soil components and plant roots in soil cores are described. Soil cores up to 10 cm in diameter and 30 cm in depth were taken in the field using steel tubes. The oven-dried cores are impregnated with embedding plastic; there is no evident disturbance of the soil within the cores except at the periphery. A diamond saw is used to cut serial sections that are sufficiently smooth for autoradiography. No-screen x-ray film is used for low resolution autoradiographs with relatively short exposure times. If sufficient radioactivity is present, finer definition is obtained with slower extra-fine-grain x-ray film. Nuclear track plates or cover glasses dipped in nuclear track emulsion make microscopic examination possible and allow differentiation between alpha and beta emitters. Alpha-, beta-, and gamma-emitting fallout radionuclides in soils collected in the Marshall Islands were localized by these methods. Radioactive portions of the cores can be cut out and analyzed by gamma spectroscopy for radiochemical analyses. It is thus possible to determine selective translocation and adsorption of specific radionuclides within the soil-plant root system. The principal radionuclides in the soils that have been studied using this technique are $^{54}$Mn, $^{60}$Co, $^{90}$Sr, $^{125}$Sb, $^{137}$Cs, $^{144}$Ce, $^{155}$Eu, and $^{239}$Pt. (auth)

**32107** LIQUID SCINTILLATION COUNTING OF ALPHA-EMITTERS. Ihle, H. R.; Karayannis, M.; Murrenhoff, A. P. (Kernforschungsanlage, Julich, Ger., and Universitat, Bonn). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/14, 26p. (CONF-650507-5)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Methods to obtain accurate and consistent liquid scintillation counting results for alpha emitters are described: formation of organic complexes with the radionuclide; dissolving the nuclide as radiocolloid; use of sample containers with scintillating walls; and transforming the liquid scintillator loaded with the sample into a gel. Complexing the radionuclides with the practically non-quenching complexing agent tri-n-octylphosphine oxide (TOPO) in a liquid scintillator based on dioxane as solvent was found to be one of the best methods for counting uranium, plutonium, transplutonium elements, and lanthanides even in samples with high content of inactive salts or organic materials. The other methods described have the advantage of not being limited in applicability by the chemical properties of a complexing agent; these methods can for instance also be applied to counting polonium. Data for the following factors influencing reproducibility and accuracy of the counting results are given for different counting conditions: width of the alpha-peak, peak-to-total ratio, quenching, gamma-

and noise-background, and interference by other radionuclides. The application of the method for standardizing alpha-active solutions, the limits of sensitivity for counting low-level samples, and the possibilities of counting more than one radionuclide in one sample are discussed. The methods described are applicable with advantage for the evaluation of biological samples, for instance from metabolism or decorporation studies involving alpha-emitters. (P.C.H.)

**32108** THE SCINTILLATION COUNTING OF CALCIUM-45. Carr, T. E. F.; Parsons, B. J. (Medical Research Council, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/2, 20p. (CONF-650507-20)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

A review is made of some of the methods for the assay of calcium-45 in biological materials. Experience gained from the assay of calcium-45 in such materials, using a liquid scintillation technique, is reported. Difficulties were found with certain samples due to the presence of relatively large amounts of iron. The quenching of the scintillator due to this iron and methods for overcoming it are discussed. Results are given of the use of external gamma sources as standards and as a means of estimating quenching effects in certain samples. Though not entirely satisfactory for the measurement of quenching their use as a standard for checking counter performance is recommended. A comparison of the methods, including liquid and plastic scintillation counting of calcium-45, is given covering the following aspects: efficiency, background; ease and speed of sample preparation; use of standards and reproducibility; and stable calcium capacity. Recommendations are made as to which technique is most suitable under given circumstances. (auth)

**32109** DETECTION AND ASSAY OF COMPOUNDS OF BIOLOGIC INTEREST BY USE OF RADIOHALOGENATION. Spencer, R. P. (Yale Univ., New Haven). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/48, 14p. (CONF-650507-21)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Three possible approaches to the detection and quantitation of organic compounds on chromatograms are discussed: exposure of the organic compound to a radioactive halogen and count directly; exposure of the sample to a stable halogen and then activate the material, such as by neutron bombardment (for example, $^{127}I + n^1 \rightarrow {}^{128}I$) this, of course, also works for compounds that contain a halogen in nature; and production of the radiohalogen directly on the chromatogram, as by the coupled reactions $^6Li(n,^4He)^3H$, $^{16}O(^3H,n)^{18}F$. In a chromatographic spot containing g grams of an organic compound of molecular weight m, there are g/m moles. If n halogen atoms bind to each organic molecule, and the halogen has a specific activity of s microcuries/mole, the number of microcuries (M) in the spot is: M = g.n.s/m. As an example of activities to be expected, $^{36}Cl$ is supplied with a specific activity of 10,000 to 60,000 μC/mole. One micromole of an organic compound binding ½ $Cl_2$ would thus contain .005 to .03 μC of $^{36}Cl$. Greater activity can be achieved by binding chlorine and activating on paper to produce $^{38}Cl$. With its high cross section (0.56 barns), and the 0.245 abundance of $^{37}Cl$, the $^{37}Cl + n^1 \rightarrow {}^{38}Cl$ reaction can produce $5.1 \times 10^4$ μC/gm of chlorine irradiated (flux of $10^{12}$ neutrons/cm$^2$/sec for 1 hr). One micromole of organic compound binding one micromole of chlorine would contain about 2 μC of $^{38}Cl$. (P.C.H.)

**32110** THE DETERMINATION OF COMPONENTS OF RADIOACTIVE DECAY MIXTURES BY COMPUTER ANALYSIS OF COUNT-RATE DATA. Fairman, W. D.; Tyler, S. A.; Dipert, M. H.; Sedlet, J. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/42, 26p. (CONF-650507-19)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Selection of decay components of radioactive isotopes by a least-squares procedure provides better estimates than solution by simultaneous equations alone. Consequently, a least-squares Fortran computer program (designated CORD) was developed which solves the general problem: given the times and counts per unit time from a sample, the possible radioisotopic parents and decay schemes and all associated decay constants and detection efficiencies compute the amount of each parent actually present at a predetermined zero time. In addition, the program yields the amounts of the parents and daughters present at all data times. Initially used with bioassay and environmental samples, the program has been specifically designed for analyzing count-rate data obtained by nonspectroscopic alpha or beta counting. However, it should be adaptable to total gamma and spectroscopic data, provided the energy ranges over which these measurements are made permit correlations between the data obtained and the total decay and growth rates. The development of the program and the results obtained from theoretical and experimental data used to test it are discussed. (P.C.H.)

**32111** SPECTROMETRIC ANALYSIS OF BETA-RADIATION USING SEMICONDUCTOR DETECTORS. Hashizume, A.; Legrand, J.; Hareux, F. (Centre d'Etudes Nucleaires, Saclay, France). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/66, 24p. (In French). (CONF-650507-18)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The identification and analysis of pure $\beta$ emitters are often necessary in connection with the biological and medical applications of radioisotopes. Junction, surface-barrier and lithium-ion drift silicon detectors were used to analyze complex $\beta$ spectra. The detectors were placed in a vacuum ($10^{-3}$ mm Hg) at a temperature of –30°C. The resolving power of the best detector varied with temperature from 20 to 8 kev. Since the stability and resolving power of the spectrometer with junction detectors were far superior to those of the counters with organic scintillators, analytical precision was substantially improved. The results obtained for a large number of mixtures, including $^{32}P + {}^{33}P$, $^{89}Sr + {}^{90}Sr + {}^{90}Y$), etc., were compared. The results bring out the considerable advantages of this method (ease of analysis, precision, detection of low concentrations, etc.) over the conventional techniques. (auth)

**32112** A UNIVERSAL METHOD FOR RADIO-GAS-CHROMATOGRAPHY AND FOR THE FAST DETERMINATION OF CARBON-14 AND/OR TRITIUM-LABELLED SUBSTANCES INDEPENDENT OF OTHER ELEMENTS PRESENT. Simon, H.; Muellhofer, G.; Medina, R. (Technische Hochschule, Munich). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/15, 22p. (CONF-650507-16)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

A successful method for analyzing both $^{14}C$- and T-labeled compounds independent of their composition is reported. The following types of compounds containing elements besides C,H,O were investigated and showed no particular difficulties: substances containing nitrogen, as amino or nitro groups; sulphur, as thioethers; fluorine, as an N-trifluoroacetylamino acid; chlorine, bromine, and iodine containing compounds; and benzene, toluene, and water, etc. The substances are cracked in a current of hydrogen gas in a reactor containing Zn and Ni on a support. With this apparatus, a quick analysis of marked substances can also be obtained by direct injection into the reactor. The reproducibility and applicability of this method is also reported. (P.C.H.)

**32113** THE SIMULTANEOUS DETERMINATION OF $H^3$ AND $C^{14}$ RADIOACTIVITY IN BIOLOGICAL MATERIALS BY MEANS OF AN INTERNAL PROPORTIONAL GAS COUNTING TUBE. Tykva, R. (Inst. of Organic Chemistry and Biochemistry, Prague). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/28, 22p. (CONF-650507-17)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

A method for the simultaneous relative determination of $^{3}H$ and $^{14}C$ radioactivity in biological materials is described. The dry sample is placed in an oxidation tube and buried under a layer of the product of thermal decomposition of silver permanganate, serving as an oxidation reagent and retaining sulfur dioxide and the oxidation products of halogens, phosphorus, and arsenic as well. A stream of inactive carbon dioxide carrying the mixture of water vapor and carbon dioxide formed by oxidation into the following tube filled with finely ground calcium carbide flows continuously through the oxidation tube. The carbide reacts with the water vapor forming acetylene. The gas mixture is then introduced by the carrier carbon dioxide into a layer of pyroforic iron, which retains traces of oxygen escaping from the oxidation reagent. If nitrogen-containing samples are processed, the filling line is supplemented by a layer of manganese dioxide. After passage of the absorbing layers the mixture of tritiated acetylene and $^{14}C$-labeled carbon dioxide is introduced by the carrier gas continuously into the counter filled with inactive acetylene to a partial pressure of 150 torr. The total pressure is 910 torr. The procedure described enables one person to carry out more than 40 fillings within 8 working hours. The results obtained by this method, in a $2\pi$ windowless flow counter and in a dual channel refrigerated scintillation counting system, were compared on actual experiments. (P.C.H.)

**32114** SENSITIVITY OF BREMSSTRAHLUNG ACTIVATION ANALYSIS FOR IODINE DETERMINATION. Mulvey, P. F. Jr.; Cardarelli, J. A.; Meyer, R. A.; Cooper, R.; Burrows, B. A. (Boston Veterans Administration Hospital; Army Natick Labs., Boston; and Boston Univ.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/49, 15p. (CONF-650507-15)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The sensitivity of activation analysis using bremsstrahlung irradiation to measure trace quantities of inorganic iodide was studied. The sample material to be analyzed was prepared in distilled $H_2O$ and then passed at a flow-rate of 1 ml/min through polyethylene disposable syringes containing 1 ml of Dowex 50 W-X-8 cation exchange resin, and 1 ml of Dowex 1-X8 anion exchange resin. To test binding capacity of anion resin, a 10 ml aliquot of $^{131}I$ was passed over the resins and counts were made of both resins plus the effluent material. The results indicated that 99% of the $^{131}I$ was adsorbed by the anion resin. The anion resin column containing the $^{127}I$ to be assayed was made radioactive by bremsstrahlung (gamma photon) activation irradiation using a 22 Mev linear accelerator. Each sample, still within the polyethylene syringe, was placed directly behind a 6 cm thick $H_2O$ cooled aluminium block. The electrons from the linac beam were captured in the block and the resultant bremsstrahlung activated the $^{127}I$ in the resin column. Spectral analysis of the $^{126}I$ produced indicated two major gamma rays, 0.386 Mev (34%) and 0.650 Mev (33%). The energy interval selected for $^{126}I$ counting was between 0.300 and 0.450 Mev for the low energy peak, and between 0.570 and 0.720 Mev for the upper energy peak. The samples and standards were measured in a shielded $1\frac{3}{4}$ in. × 2 in. NaI(Tl) well integral assembly connected to a dual window analyzer which was calibrated with a $^{133}Ba$ and a $^{137}Cs$ source. Each energy peak was then simultaneously recorded with two glow tube scalers. The counting efficiency for the 0.386 peak was 50% with a background count of only 25 cpm, while the 0.650 peak indicated 35% efficiency with a 16 cpm background. The results indicated that 1 $\mu$g of $^{127}I$ can easily be measured, with a coefficient of variation of 0.56%. (auth)

**32115** GAS CHROMATOGRAPH. Carle, Don W.; Burnell, Maurice R. (to Beckman Instruments, Inc.). U. S. Patent 3,174,326. Mar. 23, 1965. Filed Feb. 24, 1958.

The gas chromatograph patented will accommodate samples of 20 to 500 times greater mass than analytic chromatographs while maintaining substantially the same degree of resolution. The apparatus has a plurality of columns operated in parallel and fed through manifolds that can be switched to provide various column flow configurations. A totally enclosed system permits recirculating the carrier gas or recycling the sample for increased resolution. A monitoring system for indicating when given components are emerging from the column and a series of traps for removing various components are included. A temperature-controlled vaporizer for liquid samples is provided. (A.G.W.)

**32116** EXCITATION SOURCE FOR EMISSION SPECTROSCOPY. Dewey, Davis, R.; II; Kopito, Louis (to Baird-Atomic, Inc.). U. S. Patent 3,174,393. Mar. 23, 1965. Filed June 29, 1961.

Spectroscopic instruments are described in which graphite fabric, woven or felted, serves as a source for excitation of emission spectra in spectrochemical analysis. The graphite material is capable of converting supplied electrical energy into thermal energy with high efficiency and may be utilized to provide the necessary excitation by itself or may be energized in conjunction with a conventional source of excitation such as a flame in a flame photometer. In addition to its primary function as a source of excitation, the graphite material may be employed to support the specimen in a spectrometer. The material may serve as an electrode in an arcing flame photometer. (A.G.W.)

## Inorganic and Physical Chemistry

*Refer also to abstracts 32713, 32714, 32755, 32924, and 33653.*

**32117** (ANL-7004) PROPERTY VALUES OF PARA-HYDROGEN. Stephenson, Mark E. (Argonne National Lab., Ill.). Mar. 1965. Contract W-31-109-eng-38. 167p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Tables are presented of the properties of para-hydrogen from 36 to 5400°R and from 14.7 to 2400 psia, as calculated by the H2P code of O.A. Farmer. The properties include enthalpy, entropy, specific volume, specific heat, viscosity, thermal conductivity, and Prandtl number. Graphs are also presented of the molecular weight, specific impulse in vacuum, vapor pressure, latent heat of vaporization, surface tension, parahydrogen percentage, and sonic velocity. Some comparisons of the results with previous data are given. (D.L.C.)

**32118** (ANL-7020(p.165-74)) CALORIMETRY. Argonne National Lab., Ill.).

Fluorine bomb calorimetry was used to measure the enthalpies of formation of the following compounds: $PF_5$, $SF_6$, $SeF_6$, $ZrB_2$, $HfB_2$, $NbB_{1.9}$, $TaB_{1.9}$, $BF_3$, $MgF_2$, $YF_3$, $AlF_3$, $HoF_3$, and SiC. Descriptions are given of a fluorine-flow calorimeter, a quartz-crystal thermometer, and two enthalpy calorimeters of the drop type for use up to 1500 and 2500°C. (D.L.C.)

**32119** (BNL-9171) SOME ASPECTS OF ELECTRON EXCHANGE REACTIONS IN SOLUTION. Sutin, Norman (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 14p. (CONF-650520-2; SM-64/33) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From IAEA Symposium on Exchange Reactions, Upton, N. Y.

Calculations were made for rates of electron transfer reactions involving metal ions and their complexes. Outer-sphere and inner-sphere reactions are included as well as the hydrated electron. The results are compared with experimental data. (D.L.C.)

**32120** (IS-1121) STABILITY CONSTANTS OF SOME LANTHANIDE-ALIPHATIC $\alpha$-HYDROXYCARBOXYLATES. Fleischer, David; Powell, Jack E. (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-eng-82. 117p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The stability constants of the trivalent rare earth ions

with the ethylglycolate, ethylmethylglycolate, and diethylglycolate ligands were determined at 25°C and an ionic strength of 0.1, using sodium perchlorate as a supporting electrolyte. Factors determining the stability of the chelates were discussed. (auth)

**32121** (MATT-324) KINETICS OF THE THERMAL DECOMPOSITION OF LITHIUM NITRATE. Cho, S. H; Johnson, E. F. (Princeton Univ., N. J. Plasma Physics Lab.). Dec. 1964. Contract AT(30-1)-1238. 140p. Dep.; $4.00(cy), 3(Mn) CFSTI.

Thermal decomposition of lithium nitrate in the presence of argon was investigated at constant volume in an agitated gold-lined vessel at 450 and 500°C. The kinetic model, consisting of $LiNO_3 \xrightleftharpoons[k_2]{k_1} LiNO_2 + \frac{1}{2}O_2$ as the major reaction and $LiNO_3 + LiNO_2 \xrightleftharpoons[k_4]{k_3} Li_2O + 2NO_2$ as the minor reaction, gave the best fit to the experimental data, and the rate constants for this model were determined. In the presence of argon of approximately 0.1 atm at room temperature, the rate constants estimated from the experimental data for this kinetic model are $k_1 = (0.240 \pm 0.005) \times 10^{-2}$, $k_2 = (0.459 \pm 0.017) \times 10^{1}$, $k_3 = (0.358 \pm 0.077) \times 10^{-1}$, and $k_4 = (0.138 \pm 0.035) \times 10^{7}$ hour$^{-1}$ at 450°C, and $k_1 = (0.780 \pm 0.031) \times 10^{-2}$, $k_2 = (0.652 \pm 0.035) \times 10^{1}$, $k_3 = (0.825 \pm 0.259) \times 10^{-1}$, and $k_4 = (0.240 \pm 0.084) \times 10^{6}$ hour$^{-1}$ at 500°C, if the chemical activities are interpreted as the ratios of mole concentrations to that of the initial lithium nitrate. The experimental data fit the major reaction of the decomposition process quite well, but the fit to the minor reaction is poorer because of the relatively large errors in the measurement of the concentrations of nitrogen dioxide and the presumably heterogeneous nature of the reaction between lithium oxide and nitrogen dioxide. The activation energies for the major reaction were calculated to be 26.2 ± 1.4 and 7.8 ± 2.0 kcal/g-mole for the forward and reverse reactions respectively, and the heat of reaction was calculated to be 18.4 ± 3.3 kcal/g-mole. An increase in the amount of argon in the reaction vessel by a factor of 2 had no significant effect on the rate constants. (auth)

**32122** (NYO-2747-3) VISIBLE SPECTRA OF TRANSITION METAL CYANIDES DISSOLVED IN MOLTEN SALTS. [PART] A. SYNTHESIS AND PROPERTIES OF BORAZINES AND CYCLOTRIBORAZANES. [PART] B. Final Report. Riley, Reed F. (Polytechnic Inst. of Brooklyn N. Y.). June 11, 1965. Contract AT(30-1)-2747. 106p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The purpose of this research was to study the spectral behavior of transition metal ions dissolved in molten salts when cyanide was added to complex these metal ions. A study of the stability of these solutions was made first and the relatively more stable $[Ni(CN)_4]^{2-}$ was finally chosen for spectral work. Addition of cyanide ion to $[Ni(CN)_4]^{2-}$ resulted in a shift of the ultraviolet cutoff to longer wavelengths, similar to what happens in aqueous solutions, and these results are interpreted to mean a pentacoordinate $[Ni(CN)_5]^{3-}$ and perhaps a hexacoordinate $[Ni(CN)_6]^{4-}$ is formed. Since the stability of cyanide ion in nitrate and chloride melts is limited, the work on fused salts was dropped and work on BN ring compounds was begun. The purpose of going into the field of BN ring compounds was to provide more information in the little known area of saturated six membered BN rings—the socalled cyclotriborazanes. New synthetic routes were developed, some old synthetic routes were shown to be limited in scope, and the new cyclotriborazanes made were subjected to various reactions and physical measurements. (D.L.C.)

**32123** (ORNL-TM-989) A LITERATURE REVIEW OF MASS SPECTROMETRIC-THERMOCHEMICAL TECHNIQUE APPLICABLE TO THE ANALYSIS OF VAPOR SPECIES OVER SOLID INORGANIC MATERIALS. Redman, J. D. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 50p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A bibliography of 231 references, some with annotations, is presented on thermochemical properties of some gaseous species, mass spectrometer instrumentation, and thermodynamic properties of alkali metal halide vapors. An author index is included. (D.L.C.)

**32124** (TID-21020) SIGNIFICANCE OF SOLUBILITY DATA IN DETERMINING RATES OF SOLUTION AND DIFFUSION OF STRONTIUM-90 IN THE FORM OF STRONTIUM TITANATE. Bloom, Justin L.; Riggs, Cecil O. (Martin Co., Baltimore, Md., Nuclear Div.). [1962]. Contract AT(30-1)-2220. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An important health physics consideration in evaluating the safety of strontium titanate (the chemical form of $^{90}Sr$ employed in thermoelectric generators) is the rate of solution of strontium titanate in sea water and of the subsequent dispersal of soluble $^{90}Sr$ because of thermal gradients and diffusion velocities. Based on data obtained from solubility tests of strontium titanate pellets tagged with tracer quantities of $^{90}Sr$, the rate of solution in sea water of $^{90}Sr$ from pellets containing high concentrations of isotope is computed as a function of time, and equations are derived which determine: (1) The amount of $^{90}Sr$ in solution at a given time. (2) The maximum possible amount in solution. (3) The concentration of soluble $^{90}Sr$ both as a function of distance from the source and as a function of time. (auth)

**32125** (NP-tr-1236) ELECTROCHEMISTRY OF MOLTEN AND SOLID ELECTROLYTES. VOLUME 2. Smirnov, M. V., ed. Translation of "Elektrokhimiya Rasplavlennykh Solevykh i Tverdykh Elektrolitov." 1964. 100p. $17.50(Consultants Bureau).

Thirteen papers are presented on such topics as electrolysis of NaCl–KCl melts containing U chlorides, plating of Be onto Cu from fused salts, and structure and electric conductivity of oxide systems. Separate abstracts were prepared for 9 of the papers; another paper was abstracted previously (see NSA 19: 9715). The 3 remaining papers deal with anode solution of Ti in chloride and fluoride–chloride melts, cathode deposition and anode solution of Cu in molten CuCl, and discharge of carbonate ions on Pt anode, respectively. (D.L.C.)

*For abstracts of individual papers see: 32126, 32127, 32128, 32686, 32735, 32736, 32737, 32738, and 32739.*

**32126** (NP-tr-1236(p.1-6)) EQUILIBRIUM POTENTIALS OF URANIUM DIOXIDE ELECTRODES IN A NaCl–KCl MELT CONTAINING URANYL CHLORIDE. Smirnov, M. V.; Skiba, O. V.

The equilibrium potentials of uranium dioxide electrodes in a molten equimolar mixture of NaCl–KCl containing 0.088–8.38 wt % of $UO_2Cl_2$ (ion fraction $[UO_2^{2+}] = 1.7 \times 10^{-4} - 1.75 \times 10^{-2}$) were measured at 670–900°. It was established that within the range of concentrations investigated the Nernst equation holds true for the equilibrium potential of uranium dioxide: $E = E^0_{UO_2/UO_2^{2+}} + 0.992 \times 10^{-4} T \log [UO_2^{2+}]$. An expression was found for the temperature dependence of the value $E^0_{UO_2/UO_2^{2+}}$, appearing in this equation $E^0_{UO_2/UO_2^{2+}} = -1.031 + 6.14 \times 10^{-4} T$ v relative to a chlorine reference electrode. The thermodynamic parameters of the oxidation of uranium tri- and tetrachlorides by oxygen in a NaCl–KCl melt were calculated and expressions obtained for the temperature dependence of the equilibrium constant of the given reactions. (auth)

**32127** (NP-tr-1236(p.7-11)) DIFFUSION COEFFICIENTS OF $U^{3+}$, $U^{4+}$, AND $UO_2^{2+}$ IONS IN A NaCl–KCl MELT. Skiba, O. V.; Smirnov, M. V.; Khazemova, T. F.

The temperature dependences of the diffusion coefficients of $U^{3+}$, $U^{4+}$, and $UO_2^{2+}$ ions in an equimolar mixture of sodium and potassium chlorides were measured by the chronopotentiometric method. It was found that $D_0$ equaled 2.8, 9.5, $1.3 \times 10^{-3}$ cm$^2$/sec, respectively, and the activation energy equaled 8.7, 11.7, and 10.6 kcal/mole. (auth)

**32128** (NP-tr-1236(p.12-20)) CATHODE PROCESSES IN THE ELECTROLYSIS OF NaCl–KCl MELTS CONTAINING $UCl_3$, $UCl_4$, AND $UO_2Cl_2$. Smirnov, M. V.; Skiba, O. V.

An investigation was made of the cathode polarization of

molybdenum electrodes in NaCl–KCl–$UCl_3$ melts containing 0.5, 1.0, 3.5, and 12.0 wt % U at 690, 700, and 900° over a wide range of current densities from $10^{-4}$ to 10 amp/cm². It was confirmed that metallic uranium is deposited on the cathode as a result of the primary discharge of $U^{3+}$ ions. The nominal values of the limiting diffusion currents calculated from the geometric surface of the starting electrodes may considerably exceed the actual values as a result of the development of the surface of the cathode deposit of metal. A study was made of the cathode polarization of molybdenum and platinum electrodes in NaCl–KCl–$UCl_4$ melts containing 3.0 and 7.6 wt % U at 700, 800, and 850° over the range of current densities from $10^{-4}$ to 10 amp/cm². It was established that the deposition of metallic uranium on the cathode is preceded by residual currents connected with the discharge of $U^{4+}$ to $U^{3+}$ ions and also with the discharge of $UO_2^{2+}$, which formed very readily as a result of the reaction of the electrolyte with even traces of oxygen. Good agreement was found between the limiting diffusion currents of the discharge of $U^{4+}$ to $U^{3+}$ found experimentally and those calculated theoretically. Measurements were made of the polarization of platinum cathodes in NaCl–KCl–$UO_2Cl_2$ melts containing 1.7 and 7.6 wt % U at 700–800° over a range of current densities from $10^{-4}$ to 10 amp/cm². It was shown that uranium dioxide is deposited on the cathode like metals as a result of the direct discharge of the complex cation $UO_2^{2+}$ at more positive potentials than those at which $U^{4+}$ ions are discharged to $U^{3+}$ and these ions are discharged to the metal. (auth)

**32129** EMPIRICAL FORMULAE OF SOME ALCOHOL COMPLEXES OF QUADRIVALENT CERIUM FROM SPECTROMETRIC MEASUREMENTS. Offner, H. G.; Skoog, D. A. (Stanford Univ., Calif.). Anal. Chem., 37: 1018-21 (July 1965).

The empirical formulas of the quadrivalent cerium complexes of n-, sec-, and tert-butanol and ethylene glycol were determined from spectrometric measurements, and in all cases a 1:1 ratio of cerium to alcohol in the complexes was observed. The ethylene glycol complex was the most stable, possibly because of formation of a chelated five-membered ring structure. Experiments were carried out in both nitric and perchloric acid solutions, and the effect of acid and nitrate concentrations on the observed "instability" constants was examined. (auth)

**32130** ON THE NEW DISTRIBUTION OF ELEMENTS IN THE PERIODIC SYSTEM. Bogdan, Elena. Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 1-16(1964). (In Romanian)

The periodic classification of the elements should reproduce the variation of the three protoelements of which the atoms are constructed: electrons, protons, and neutrons. In representation by points of the elements ranked according to their order number taking into consideration these three variables, a succession of points was obtained with the shape of a spiral in space. The electrons of the exterior shell vary from 1 to 8 and increase periodically, determining the periodic winding of the spiral. The electrons and protons increase progressively by 1. The neutrons increase at the rate of 1 up to $^{18}Ar$. Then the rate of increase is no longer uniform but progressive and excessive with respect to the electrons and protons. An excess of 50 is attained, the maximum for the heaviest elements known. The neutrons determine the scalar decrease of the curve in space. The spiral is developed by zones, determined by the number of neutrons: the first zone contains the elements between $^{1}H$ and $^{18}Ar$ and is shaped as a spherical block. The second zone contains the elements from $^{18}Ar$ to $^{86}Rn$ and is shaped as a truncated cone. The third zone contains the elements from $^{86}Rn$ to $^{103}Lw$ and is shaped as another truncated cone. The whole spiral assumes in space the form of a cylinder. In the first zone are the "group heads" and "typical" elements of the Mendeleevian groups. In the second are the double triads (the natural families of representative and transitional elements), on the interposed spires, in definite positions, characterized by a difference of order numbers of 10 units. In the third zone are the elements with unstable nuclei. In assembling the elements of the vertical groups, generating curves of a cylinder are obtained. By projecting this spatial curve on the horizontal plane, a plane spiral is obtained. Each element is placed at the intersection of the curve with one of the eight symmetry radii and is found in its zone and in the vicinity of similar elements. The constant difference of 10 units between the order number of the representative elements and the order of the transitional elements (on the double radii of the intermediate zone) fixes the position of these latter, to the right or to the left of the representative elements. An exception to this rule is presented by the groups Cs–Au, Ba–Hg, and La–Tl, for which the difference between the order numbers is 24 units. This curve is continuous and predicts the positon of the elements (104 to 118) yet to be discovered. It thus gives the possibility of interposition between the elements of their isotopes whose number agree (within certain limits) with the number of excess neutrons and which should reach about 2500. The idea of Fm. Baur of taking logarithms of the numerical values of a single physical property of the elements (the atomic volume, fusion point, boiling point, ionization potential, or function of the order number) was restudied and applied to the elements of one group. The curve obtained had the form of a cylinder generator. (tr-auth)

**32131** STICKING PROBABILITY OF GASES ON METAL FILMS DETERMINED BY THE FLOW METHOD. NITROGEN ON MOLYBDENUM. McKee, C. S.; Roberts, M. W. (Queen's Univ., Belfast). Chem. Commun., No. 4, 59-61 (Feb. 24, 1965).

The sticking probabilities of nitrogen and carbonmonoxide on molybdenum film were previously determined by a flow technique and at 23°C the values were estimated to be about $2 \times 10^{-2}$. Effects of ion-gage position on calculated results are discussed. It is shown that when the real sticking probability, $\alpha$, is $\leq 0.1$ either of the two experimental arrangements (ion gage before or after the film will work), but when $\alpha > 0.01$ the position of the ion gage after the film gives the best results. The ion-gauge emission current used was 0.1 mA but, $\alpha$ was shown to be dependent on the current; being about a factor of two less with a current of 0.01 mA. Therefore, the sticking probability of nitrogen on molybdenum film was within the range where the real sticking probability, $\alpha$, and the observed sticking probability, Pr, values would be expected to differ so that mechanistic deductions based on the invariance of Pr with pressure and film weight must be regarded with some caution. (F.J.H.)

**32132** THE RATE OF VAPORIZATION OF DEUTERIUM OXIDE. Chu, H. D.; Delaney, L. J.; Eagleton, L. C. (Univ. of Pennsylvania, Philadelphia). Chem. Eng. Sci., 20: 601-5(June 1965).

The rate of vaporization of deuterium oxide was measured in the same apparatus used with ordinary water. The experimental method is based on measurement of the pressure rise in a closed system during vaporization while simultaneously measuring the surface temperature. The condensation coefficient was found to be 0.0255 at about 4°C and 0.0212 at about 25°C. Within experimental error these values gave the same temperature dependence found for $H_2O$. As in the case of $H_2O$, the values of $\alpha$ did not agree with the free angle ratio as estimated by the methods of Kincaid and Eyring and Mortensen and Eyring. However, the isotope effect, $\alpha_{D_2O}/\alpha_{H_2O}$, as predicted by the free angle ratios, was in good agreement with the experimental value of 0.65. (auth)

**32133** COMPOSITION AND STABILITY CONSTANT OF URANYL-2-HYDROXY, 3-NAPHTHOIC ACID COMPLEX. Desai, M. N. (Gujarat Univ., Ahmedabad, India). Current Sci. (India), 34: 312-13(May 20, 1965).

The complex formation of uranium with 2-hydroxy-3-naphthoic acid was studied and its composition was established. The complex attained its maximum spectral intensity at a pH = 4.0 and contained uranyl and the reagent in a 1:1 ratio. The color of the complex was red. (M.C.G.)

**32134** STUDIES OF X-RAY L SPECTRA OF RARE EARTH COMPOUNDS. Blokhin, S. M.; Vainshtein, E. E. (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR). Fiz. Metal. i Metalloved., 19: 371-4(Mar. 1965). (In Russian)

Preliminary results are given on the estimate made of the magnitude and direction of shifted emission bands and boundaries of x-ray L-spectra for nf-shell deflective rare earths. The participation of 5d and 4f rare earth electrons in the chemical bond was determined by the position of x-ray absorption boundaries $L_{III}$ and the last emission line $L\beta_5$ in rare earth compounds and by approximate energy calculations of $L_{II,III}(2p)$, and $O_{IV,V}(5d)$ levels in atoms missing 4f, 5d, and 6s electrons. A relation was found between the shift magnitude of the absorption boundary $L_{III}$ and emission band $L\beta_5$ of the rare earth atoms and the element valency and its chemical interactions in the compound. (R.V.J.)

**32135** RARE-EARTH ZIRCONATES AND THEIR PHYSICO-CHEMICAL PROPERTIES. 2. PRASEODYMIUM ZIRCONATE $Pr_2Zr_2O_7$. Fan, Fu-kang; Kuznetsov, A. K.; Keler, E. K. (Grebenshchikov Inst. of Silicate Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 4, 585-8(1965). (In Russian)

A compound of praseodymium zirconate was detected with the composition $Pr_2Zr_2O_7$. The conditions for the synthesis of the zirconate were investigated and some data on its physical-chemical properties were determined. (tr-auth)

**32136** INFRARED SPECTRA OF ISOTOPE SUBSTITUTED MOLECULES OF ETHYLLITHIUM. Rodionov, A. N.; Talalaeva, T. V.; Shigorin, D. N.; Rodionova, G. N.; Kocheshkov, K. A. (Karpov Inst. of Physics and Chemistry, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 4, 604-10(1965). (In Russian)

The infrared spectra of five isotopically substituted molecules of ethyllithium and three aggregate states (pairs, solutions, and crystals) were measured in the range from 3500 to 400 $cm^{-1}$. The proximity of the spectra of ethyllithium in pairs and solutions (benzene) and their marked difference from the spectra of crystals were established. On the basis of this an hypothesis was made on the modification of the structure of the complexes by conversion in crystals. The comparison of the data from experiments and approximate calculations makes it possible to identify the fundamental width in the vibration of the separate groups ($CH_2-Li$, C–C, C–H, C–D, etc.). The dependence of the vibration frequency $CH_2-Li$ both on the substitution of $^7Li$ by $^6Li$ as well as on the deuteration of the $\alpha$-$CH_2$ group was established. The effect of the $\gamma$-$CH_3$ groups on the $CH_2-Li$ vibrations was insignificant. By partial deuteration of the ethyl radicals in ethyllithium molecules it was shown that the observed decrease in frequency of the valence vibrations of C–H was connected with the $\alpha-CH_2$ group. The decrease of the frequency of this vibration was explained by the change of the valence state of the $\alpha$-C atoms because of the inductive effect of adjacent lithium atoms as well as on the production of intermolecular bonds. The effect of isotopic substitution and the change of the aggregate state on the valence vibration of the C–C bonds was investigated. (tr-auth)

**32137** A SECONDARY KINETIC ISOTOPE EFFECT IN A SUBSTITUTION REACTION OF A SQUARE-PLANAR COMPLEX. **Falk, Charles D.; Halpern, Jack (Univ. of Chicago).** J. Am. Chem. Soc., 87: 3003-4(July 5, 1965).

The kinetic isotope effects arising from deuterium substitution on the rate of reaction of trans-$PtHCl(PEt_3)_2$ with pyridine were measured. An unusually large secondary kinetic isotope effect was observed, corresponding to a decrease in k, by a factor of 1.4 when the hydride ligand is replaced by deuteride. (M.C.G.)

**32138** THEORY OF HELIUM DISSOLUTION IN URANIUM DIOXIDE. I. INTERATOMIC FORCES IN URANIUM DIOXIDE. Olander, Donald R. (Univ. of California, Berkeley). J. Chem. Phys., 43: 779-84(Aug. 1, 1965). (UCRL-11956)

Knowledge of the nature of the interatomic forces in uranium dioxide was required for theoretical treatment of phenomena such as radiation damage, adsorption, and gas solubility. The van der Waals and repulsive forces were of particular interest, for these interactions govern the behavior of neutral species in the crystal. The Kirkwood-Müller expression for the coefficients of the $1/r^n$ dispersion forces were employed, and the form of the repulsive potentials was taken from the delta-function model of Mason and Vanderslice. The two disposable parameters in the repulsive potentials were evaluated from data on the atomic properties of the constituent ions and the lattice constant and compressibility of $UO_2$. The calculated cohesive energy of the $UO_2$ lattice was in very good agreement with the value obtained from a conventional Born–Haber cycle. (auth)

**32139** THEORY OF HELIUM DISSOLUTION IN URANIUM DIOXIDE. II. HELIUM SOLUBILITY. Olander, Donald R. (Univ. of California, Berkeley). J. Chem. Phys., 43: 785-8(Aug. 1, 1965). (UCRL-11956)

The solubility of helium in uranium dioxide was calculated directly from atomic properties and compared with experiments. The calculations were based on a statistical-mechanical formula, which assumed that dissolved helium behaved as a simple harmonic oscillator in an interstitial site in the $UO_2$ lattice. Knowledge of the interactions between helium and the oxygen and uranium ions of the lattice permitted computation of the heat of solution and the vibration frequency, which yielded the Henry's law constant. The calculated solubility of $6.6 \times 10^{-4}$ cc (STP)/g·atm at 1200°C was in good agreement with the experimental measurements but the heat of solutions differed appreciably. This discrepancy was attributed to experimental errors, for the very large observed heat of solution (~–30 kcal/mole) could not arise from purely physical interactions. (auth)

**32140** MOLAR VOLUME OF SOLID PARAHYDROGEN ALONG THE MELTING LINE. Dwyer, Robert F.; Cook, Gerhard A.; Berwaldt, Oren E.; Nevins, Hugh E. (Union Carbide Corp., Tonawanda, N. Y.). J. Chem. Phys., 43: 801-5(Aug. 1, 1965).

The molar volume ($V_s$) of solid parahydrogen along the melting line up to a temperature of about 24°K and a pressure of about 400 atm was determined by two independent methods: direct measurement and computation from the heat of fusion and change in volume during melting. Results obtained by the two methods agreed with each other within about ±0.2%. The empirical linear equation $V_s = 27.1788 - 0.283044\ T$ reproduces the results with a mean deviation of about 0.15%. (auth)

**32141** INTENSITY DISTRIBUTION IN THE ELECTRON-IMPACT SPECTRUM OF CARBON MONOXIDE AT HIGH-RESOLUTION AND SMALL SCATTERING ANGLES. Meyer, Vincent D.; Skerbele, Ausma; Lassettre, Edwin N. (Mellon Inst., Pittsburgh). J. Chem. Phys., 43: 805-16 (Aug. 1, 1965).

An electron spectrometer, which provides velocity selection before scattering is described; and the results of a study of relative intensities in the carbon monoxide spectrum are reported. The vibrational levels of the fourth positive band system were resolved and relative intensities determined for the first nine. The relative intensities were compared with calculated Franck–Condon factors. The agreement was good at low vibrational quantum numbers but noticeable discrepancies were found for high-vibrational levels. The problem of calculating relative oscillator strengths from a fully resolved spectrum was considered and applied to data obtained in the research. Relative oscillator strengths were compared with those obtained previously from unresolved spectra. If the Born approximation was valid, then the electron-impact and ultraviolet absorption spectra should be closely similar. This was actually observed for most of the spectrum but the transition at 12.79 v was an exception. The relative oscillator

strength obtained from the electron-impact spectrum exceeded that from the ultraviolet absorption spectrum by almost a factor of 3. The reason for this anomaly was not known. (auth)

**32142** RELATIVE INTENSITIES OF TWO RYDBERG TRANSITIONS IN THE ELECTRON-IMPACT SPECTRUM OF WATER. Skerbele, Ausma; Meyer, Vincent D.; Lassettre, Edwin N. (Mellon Inst., Pittsburgh). J. Chem. Phys., 43: 817-20(Aug. 1, 1965).

The electron-impact spectrum of water was determined using a higher-resolution electron spectrometer. The intensity distribution of five peaks in the spectrum, which belonged to two different Rydberg transitions, was investigated at zero scattering angle and electron kinetic energy of 200 v. Quantities proportional to the optical oscillator strengths for these excitations were compared with absorption coefficients from ultraviolet spectra. The entire electron-impact spectrum in the region below the first ionization potential showed good agreement with ultraviolet absorption. (auth)

**32143** SOME TRIPLET STATES OF THE HYDROGEN MOLECULE. Wakefield, Charles B.; Davidson, Ernest R. (Univ. of Washington, Seattle). J. Chem. Phys., 43: 834-9(Aug. 1, 1965).

The potential curves for the 2s, 3s, 3d $^3\Sigma_g^+$ states of $H_2$ were computed in the Born–Oppenheimer approximation. Some points on the potential curves for the 3d $^3\Delta_g$, 3d $^1\Delta$, 3s $^1\Sigma_g^+$, and 3d $^1\Sigma_g^+$ states were also obtained. Vibrational levels were computed in various approximations. Lambda doubling in the 3s, 3d triplet $\Sigma\Pi\Delta$ complex was discussed. This doubling was complicated by the near degeneracy of the 3s $^3\Sigma_g^+$ and 3d $^3\Sigma_g^+$ states at the equilibrium nuclear separation. (auth)

**32144** 1s3d 3-$\Pi_g$ STATE OF THE HYDROGEN MOLECULE. Wright, Wayne M.; Davidson, Ernest R. (Univ. of Washington, Seattle). J. Chem. Phys., 43: 840-3(Aug. 1, 1965).

The potential curve and vibrational-rotational levels for the 1s3d$^3\Pi_g$ states of $H_2$ were computed in the Born–Oppenheimer approximation. Energy levels about 50 $cm^{-1}$ below the experimental levels were found. A discussion of the nature of the wavefunction was given. (auth)

**32145** CONFIGURATION-INTERACTION EFFECTS ON THE "FREE-ION" ENERGY LEVELS OF $Nd^{3+}$ AND $Er^{3+}$. Rajnak, K. (Univ. of California, Berkeley). J. Chem. Phys., 43: 847-55(Aug. 1, 1965). (UCRL-11826)

By the use of three or four parameters of configuration interaction, the experimental "free-ion" energy levels of $Nd^{3+}$ and $Er^{3+}$ were fitted with an rms deviation of 45 to 55 $cm^{-1}$. The significance of the various parameter values was discussed. It was also shown that assignments based purely on comparison with a calculation using only $F_2$, $F_4$, $F_6$, and $\zeta$ may occasionally be in error. Several discrepancies in previous works were cleared up. (auth)

**32146** ELECTRONIC STRUCTURE OF SrO. Kaufman, M.; Wharton, L.; Klemperer, W. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 43: 943-52(Aug. 1, 1965).

Molecular-beam electric-resonance spectra of SrO were measured in the r-f and microwave regions. The microwave transitions were induced with a frequency-broadened klystron, greatly reducing the time needed to search for resonances. The r-f–microwave double resonance was used to establish the vibrational assignment of the r-f spectra from the known assignment of the microwave spectra. The dipole moment and rotation constant of $^{88}Sr^{16}O$ in the lowest two vibrational states were: $\mu_0 = 8.900$ and $\mu_1 = 8.874$ D, and $B_0 = 0.33688$ and $B_1 = 0.33469$ $cm^{-1}$. These rotation constants showed that this $^1\Sigma$ state is identical with the lower state of three optical-emission systems of SrO. With the aid of a molecular-beam magnetic-deflection experiment, it was shown that this state is almost certainly the ground electronic state of SrO. The evidence indicating triplet ground or low-lying states in SrO and the other alkaline-earth oxides was reviewed, and it was concluded that in no alkaline-earth oxide was a triplet ground state established. SrO had the largest percent ionic character, $\mu/er$, yet observed for any diatomic molecule. The dipole-moment function $\mu(r)$ of SrO differed considerably from that of BaO and cannot be explained by a model of two polarizable ions. A description of the bonding in the alkaline-earth oxides can be obtained from comparisons of recent SCF calculations on LiF and BeO. (auth)

**32147** KINETICS OF THE HYDROFLUORINATION OF THORIUM DIOXIDE. Lindstrom, R. M.; Ellis, W. P. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 43: 944-7(Aug. 1, 1965). (LA-DC-6963)

Uniformly colored and optically isotropic interference films of thorium tetrafluoride were formed on the polished trigonal faces of single crystals of thorium dioxide by reactions with gaseous hydrogen fluoride. The kinetics were determined spectrophotometrically at six temperatures in the interval from 218 to 327°C. The reaction was diffusion controlled with the film thickness proportional to the square roots of pressure of HF(g) and time corrected for an incubation period. The rate constant was $\beta = 7.0 \times 10^2 \exp(-6630/RT)$ Å/(sec · Torr)$^{\frac{1}{2}}$ within an error (75% confidence) of ±280 cal/mole for the heat of activation. (auth)

**32148** FLUORESCENCE DECAY OF RARE-EARTH IONS IN CRYSTALS. Barasch, G. E.; Dieke, G. H. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 43: 988-94 (Aug. 1, 1965).

The decay of individual fluorescent transitions excited by monochromatic radiation was measured for most rare earths in hexagonal $LaCl_3$ and other lattices. At 4°K the decay was found to be invariably exponential within the experimental errors; at higher temperatures it could occasionally be represented by several exponentials with different lifetimes. The data show that the free interval below the excited level was important for determining the probability for radiationless transitions. For $Pr^{3+}$ in $LaCl_3$, there was evidences that imprisonment of radiation prolongs noticeably the fluorescence lifetimes. (auth)

**32149** EMISSION SPECTRUM AND THERMODYNAMIC PROPERTIES OF RUTHENIUM MONOXIDE. Raziunas, Victor; Macur, George; Katz, Sidney (IIT Research Inst., Chicago). J. Chem. Phys., 43: 1010-15(Aug. 1, 1965).

The band spectra attributed to the monoxides of ruthenium, rhodium, osmium, iridium, platinum, and rhenium were observed. A vibrational analysis of ruthenium monoxide and partial rotational analysis of the 0–0 band of ruthenium monoxide was carried out. The band system was tentatively attributed to a $^3\Sigma^+ \rightarrow X\ ^3\Sigma^+$ electronic transition. The values of the vibrational constants were $\omega_0' = 878.1$, $\omega_0'x_0' = 22.4$; $\omega_0'' = 880.8$, and $\omega_0''x_0'' = 13.1$ $cm^{-1}$. The values of the rotational constants were $B_0' = 0.393$ and $B_0'' = 0.422$ $cm^{-1}$, corresponding to internuclear distances $r_0' = 1.76$ and $r_0'' = 1.70$ Å. The spectroscopic constants determined in this study were used to calculate the thermodynamic functions up to 3000°K. (auth)

**32150** ISOTOPIC MIXING IN NITROGEN CHEMISORBED ON W. Yates, John T. Jr.; Madey, T. E. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 43: 1055-9(Aug. 1, 1965).

The chemisorption of an equimolar mixture of $^{14}N_2$ and $^{15}N_2$ on polycrystalline tungsten was studied. The flash-filament mass-spectrometer technique was used at sample temperatures of 77°K and above, in an ultrahigh vacuum system. The molecular identity of the low-temperature $\gamma$ state was confirmed since the $\gamma$-$N_2$ desorption spectrum showed no formation of $^{14}N^{15}N$. On the other hand, the strongly held $\beta$ nitrogen was completely isotopically mixed on desorption. A careful study of $\beta$ nitrogen, using $^{15}N_2$, revealed two overlapping binding states, $\beta_1$ and $\beta_2$, associated with surface heterogeneity in the W substrate. The $\beta_1$ state showed first-order desorption kinetics, and the more tightly bound $\beta_2$ state appeared to desorb with higher-

order kinetics. Under saturation conditions, the coverage of $\beta$ nitrogen was essentially constant from 300 to 1100°K. (auth)

**32151** DETERMINATION OF THE PHONON SPECTRUM OF POLYETHYLENE BY NEUTRON SCATTERING. Summerfield, G. C. (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 43: 1079-80(Aug. 1, 1965).

Incoherent scattering from the hydrogen atoms in determination of the phonon spectrum of polyethylene by neutron scattering was considered. The polyethylene targets were highly crystalline (≥90%). The results indicated that intermolecular forces introduce some structure in the low-energy part of the scattered neutron spectrum. It was believed that this structure was observed in neutron experiments. Calculations are being made of the polarization vectors. (F.J.H.)

**32152** DEHYDRATION AND THERMAL DECOMPOSITION OF URANYL NITRATES IN THE PRESENCE OF STEAM. Lodding, W.; Ojamaa, Linda (Rutgers Univ., New Brunswick, N. J.). J. Inorg. Nucl. Chem., 27: 1261-8(June 1965).

DTA (differential thermal analysis) and effluent gas analysis of uranyl nitrate hexahydrate and uranyl dihydrate performed in a stream of either dry air or water vapor showed essential differences in the mechanism of dehydration and decomposition. In steam both reactions were complete at approximately 210°C. The end product was $UO_3 \cdot 0.8\ H_2O$. In dry air dehydration was complete at approximately 220°C and, although the decomposition of the nitrate started below 200°C, it was complete only after reaching 290 to 300°C. Both reactions were sharply dependent on heating rate and on particle surface area. Weight loss curves obtained at constant temperatures are sometimes misleading. Transient systems such as DTA are considered likely to give a more realistic picture. A technique for DTA in a stream of water vapor close to the dew point is described. (auth)

**32153** COMPLEXES OF ORGANOMETALLIC COMPOUNDS. VIII. THE ETHYLMERCURY-THIOCYANATE SYSTEM. Barbieri, R.; Giustiniani, M.; Cervo, E. (CNR, Padua). J. Inorg. Nucl. Chem., 27: 1325-34(June 1965).

By means of anion exchange paper chromatography and paper electrophoresis it was found that $C_2H_5HgSCN$ forms negatively charged thiocyanate complexes in aqueous KSCN. The complexes $C_2H_5HgSCN_n^{1-n}$ were studied by anion exchange techniques. It was established that n ranges from 1 to 3, and the stepwise stability constants of the complexes $C_2H_5HgSCN_2^-$ and $C_2H_5HgSCN_3^{2-}$ were calculated. The invasion of Amberlite IRA 400 by KSCN (which is necessary for the employment of the anion exchange method) was determined by the anion exchange paper chromatography of KI, using aqueous KSCN as solvent, and checked by direct measurements of the invasion. (auth)

**32154** THIOCYANATE COMPLEXES OF SOME TRIVALENT LANTHANIDE AND ACTINIDE ELEMENTS. Choppin, G. R.; Ketels, J. (Centre d'Etude de L'Energie Nucleaire, Mol, Belg.). J. Inorg. Nucl. Chem., 27: 1335-9(June 1965).

The stability constants for the formation of $MSCN^{2+}$ and $M(SCN)_2^+$ where M = Nd(III), Eu(III), Pu(III), Am(III), Cm(III), and Cf(III) were determined using the solvent extraction method and an ionic strength of 1.00 M. The enthalpy and entropy values for the formation of $NdSCN^{2+}$ and $AmSCN^{2+}$ indicated that these complexes are outer sphere ion pairs. (auth)

**32155** SPECTRA OF DOUBLY AND TRIPLY IONIZED YTTERBIUM, Yb III AND Yb IV. Bryant, B. W. (Johns Hopkins Univ., Baltimore). J. Opt. Soc. Am., 55: 771-9 (July 1965).

The emission spectrum of ytterbium was photographed under varied conditions from 600 to 11,000 A in order to obtain a complete description of the spectra of the doubly and triply ionized species. The main transition arrays of these species were identified, and where feasible, the analysis was carried through. All 41 energy levels, 28 odd and 13 even, belonging to the $4f^{14}$, $4f^{13}$ 5d, $4f^{13}$ 6s, $4f^{13}$ 6p, and $4f^{13}$ 7s configurations of Yb(III) were experimentally determined along with the appropriate quantum numbers. Eleven of 20 possible $4f^{13}$ 6d levels and their quantum numbers were also determined. Many Yb(III) levels are supported by intermediate coupling calculations. The ionization potential of Yb(III) was determined to be 25.4 ± 0.5 ev from the Rydberg formula. The two $^2F$ $4f^{13}$ levels of Yb(IV) were determined in addition to 20 of a possible 107 $4f^{12}$ 5d levels, of which a few are expected to be spurious. (auth)

**32156** WAVELENGTHS IN THE SPECTRUM OF $^{86}$Kr I BETWEEN 6701 AND 4185 Å. Cook, A. H. (National Physical Lab., Teddington, Middx., Eng.). J. Opt. Soc. Am., 55: 780-2(July 1965).

Results of measurements previously reported were recalculated to give values of wavelengths as observed through the anode end of an Engelhard d-c lamp and some possible systematic effects are discussed. The measurements were compared with others made by Kaufman and Phelps and it was found that means of the three sets of data may be relied upon to 0.0001 Å. (auth)

**32157** MEASUREMENT OF FLUORESCENCE YIELDS OF EUROPIC ION UPON EXCITATION TO SELECTED LEVELS. Dawson, William R.; Kropp, John L. (TRW Space Technology Labs., Redondo Beach, Calif.). J. Opt. Soc. Am., 55: 822-8(July 1965).

A modification of a method developed by Weber and Teale is described, which permits determination of fluorescence yields on excitation to narrow, atomic energy levels. This was applied to solutions of $Eu(NO_3)_3 \cdot 6H_2O$ in $CH_3OH$ and $Eu(NO_3)_3$ in $CH_3OD$. Upper europic ion levels ($^5D_0$, $^5D_1$, $^5D_2$, $^5D_3$, and $^5L_7$) were individually excited and the emission from the $^5D_0$ level was observed. Results showed that fluorescence yields are higher in the $CH_3OD$ than in the $CH_3OH$ solution, that the probabilities of populating the $^5D_0$ level from higher-lying levels are less than unity, and that these probabilities are nearly equal in the $CH_3OH$ and $CH_3OD$ solutions. (auth)

**32158** ACTIVITIES OF THE THREE COMPONENTS IN THE SYSTEM WATER–NITRIC ACID–URANYL NITRATE HEXAHYDRATE AT 25°. Davis, W. Jr.; Lawson, P. S.; deBruin, H. J.; Mrochek, J. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 69: 1904-14(June 1965). (ORNL-P-1112)

Partial pressures of water and nitric acid over solutions containing water, nitric acid, and uranyl nitrate hexahydrate (UNH) were measured at 25°C by use of the vapor transpiration technique for solutions containing 0 to 2.3M UNH and 1 to 14M $HNO_3$. These data were analyzed in terms of activities in the two two-component systems, water–nitric acid and water–uranyl nitrate hexahydrate, and an integral form of the Gibbs-Duhem equation. From the analysis four parameters were obtained to describe the variation of water and nitric acid activities with acid and UNH concentrations. The same parameters were contained in an equation (obtained by use of cross differentiation) that describes the variation of the UNH activity coefficient with acid and UNH concentrations. Standard deviations of water and nitric acid activities were about ±1%. Data on the solubility of UNH in $H_2O$–$HNO_3$ solutions and equational representation of activity coefficients of $HNO_3$ in water and of UNH in water are presented. (auth)

**32159** THE EFFECT OF IONS ON THE SELF-DIFFUSION OF WATER. I. CONCENTRATION DEPENDENCE. McCall, David W.; Douglass, Dean C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem., 69: 2001-11(June 1965).

The self-diffusion coefficient of water was measured as a function of concentration for several ionic solutions at 23°C. Most ions tended to reduce the water diffusion rate but a few increased the diffusion rate. The observed concentration dependences for self-diffusion were closely correlated with concentration dependences for the fluidity. The data are presented in relation to other experimental

quantities and certain theoretical models. Hydration numbers were deduced and are discussed. An attempt was made to adapt Kirkwood's statistical results to water in a semiempirical manner. (auth)

**32160** KINETICS OF HYDROGEN REDUCTION OF URANIUM TRIOXIDE. Heiskala, Victor H. (Michigan Technological Univ., Houghton, Mich.). J. Phys. Chem., 69: 2012-16(June 1965).

The reaction between uranium trioxide ($UO_3$) and pure hydrogen was investigated in the temperature range from 575 to 750°C. It was determined that, after an induction period in which the reduction rate reached its maximum value, the reaction proceeded at a constant rate, which was independent of the thickness of the reduced uranium dioxide ($UO_2$) layer. The rate-limiting step in the reduction was the reaction at the $UO_3-UO_2$ interface. Microscopic examination and x ray powder patterns of samples partly reduced below 750°C failed to reveal the presence of oxides intermediate between $UO_3$ and $UO_2$ at this interface. The activation energy for the reduction was determined experimentally to be 33.3 ± 0.3 kcal/mole. Absolute reaction rate theory was used to develop an analytical expression for the rate of reduction assuming an immobile adsorbed $H_2O$ layer as part of a ($H_2O-UO_2$) complex. The rate constants calculated with this model agreed favorably with experimental values when compared on an equivalent basis. (auth)

**32161** THE VOLATILIZATION OF MOLYBDENUM IN THE PRESENCE OF WATER VAPOR. Belton, G. R.; Jordan, A. S. (Univ. of Pennsylvania, Philadelphia). J. Phys. Chem., 69: 2065-71(June 1965).

A study was made, using the transpiration technique, of the enhanced volatility of molybdenum in mixtures of water vapor, hydrogen, and argon. The major volatilization is shown to occur by the reaction $Mo(s) + 4H_2O(g) = MoO_3H_2O(g) + 3H_2(g)$. The standard free energy change for the reaction between 1200 and 1500°C is given by $\Delta F^0 = 40{,}410 - 7.10T$. The standard free energy changes for the reactions $Mo(s) + 3H_2O(g) = MoO_3(g) + 3H_2(g)$ and $Mo(s) + 2H_2O(g) = MoO_2(g) + 2H_2(g)$, obtained by combination of this work with mass spectrometric studies from the literature, are given by $\Delta F^0 = 100{,}120 - 33.99T$ and $\Delta F^0 = 119{,}900 - 41.04T$, respectively. (auth)

**32162** FLUORINE BOMB CALORIMETRY. X. THE ENTHALPIES OF FORMATION OF NIOBIUM AND TANTALUM PENTAFLUORIDES. Greenberg, Elliott; Natke, Carol A.; Hubbard, Ward N. (Argonne National Lab., Ill.). J. Phys. Chem., 69: 2089-93(June 1965).

The energies of formation of niobium and tantalum pentafluorides were measured by direct combination of the elements in a bomb calorimeter. From these measurements the standard enthalpies of formation, $\Delta Hf^0_{298.15}$, of niobium and tantalum pentafluorides were calculated to be $-433.50 \pm 0.15$ and $-454.97 \pm 0.19$ kcal mole$^{-1}$, respectively. (auth)

**32163** ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF THE NEPTUNYL ION. Eisenstein, J. C.; Pryce, M. H. L. J. Res. Natl. Bur. Std. 69A: 217-35(May-June 1965).

The magnetic and spectroscopic properties of the neptunyl ion are considered. The effect on the energy levels of covalency is discussed. New values for the parameters of the theory developed previously were obtained. The analysis was based on more recent spectroscopic data and arguments concerning the relative widths and intensities of the optical absorption peaks. The g-values and the temperature-independent susceptibility were calculated and the results compared with experimental values. Experiments which need to be done to confirm various parts of the theory are suggested. (auth)

**32164** $F^{19}$ NUCLEAR MAGNETIC RESONANCE LINE NARROWING IN $LaF_3$ AT 300°K. Lee, Kenneth; Sher, Arden (Varian Associates, Palo Alto, Calif.). Phys. Rev. Letters, 14: 1027-9(June 21, 1965).

The fluorine nuclear magnetic resonance (NMR) of a single crystal of lanthanum trifluoride, $LaF_3$, was investigated at 16.00 Mc in the temperature range from 173 to 573°K. The resonance line was observed to begin motionally narrowing at 300°K. This is surprising since the melting point of $LaF_3$ is 1770°K. The details of this observation are presented. (M.O.W.)

**32165** NEW ANISOTROPY EFFECT IN PLASTICALLY DEFORMED POTASSIUM CHLORIDE COLORED BY IONIZING RADIATION. Damm, J. Z. (Univ. of Wroclaw, Poland). Phys. Status Solidi, 9: 721-5(1965).

Potassium chloride crystals containing R-centers were illuminated with polarized white or monochromatic light in the wavelength range 475 to 550 nm or 625 to 825 nm and were studied with a polarization microscope. Blue and red colored zones were observed which overlap the stress birefringence pattern. It is shown that this phenomenon results from the superposition of two effects: the stress birefringence resulting from the plastic deformation and a bulk birefringence induced by the action of the polarized light. The experiments indicate that R-centers which are preferentially oriented along one of the ⟨110⟩ directions are responsible for the observed effect. (auth)

**32166** OPTICAL AND DIELECTRIC PROPERTIES OF KCl GROWN FROM AQUEOUS SOLUTION. Giudici, M. (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Phys. Status Solidi, 9: 727-30(1965).

The existence of different types of imperfections in melt-grown and solution-grown KCl crystals was shown experimentally by three techniques: optical absorption in the sample after x irradiation, depolarization thermocurrent, and thermoluminescence. The results show that the latter type of crystals contains a larger concentration of dipolar complexes and shallow traps, but a smaller concentration of vacancies and divalent impurities. (auth)

**32167** LUMINESCENCE OF M-CENTERS IN NaF CRYSTALS. Podini, P. (Universita, Milan). Phys. Status Solidi, 9: 737-42(1965).

The excitation spectra of M-luminescence was investigated in the spectral range of F-band absorption as a function of the concentration of both the centers. Since no interaction between the F- and M-centers is found, it is concluded that in NaF, as in other alkali halides, a second M-absorption band is hidden by the F-band. Moreover, an ageing effect, observed under x irradiation, was studied by measurements on M-emission and -absorption. The results show that the growth of M-centers under irradiation is aided by a stable center which takes part in the dynamic equilibrium between the F- and M-centers. (auth)

**32168** DETERMINATION OF PARAMETERS OF THE ROTATIONAL DYNAMICS OF THE GROUPS $NH_4$ IN $NH_4ClO_4$ AND $H_3O$ IN $H_3OClO_4$ BY INELASTIC SCATTERING OF NEUTRONS. Janik, J. M.; Janik, J. A.; Bajorek, A.; Parlinski, K. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Status Solidi, 9: 905-11(1965).

Measurements of inelastic neutron scattering in $NH_4ClO_4$ and $H_3OClO_4$ were made from liquid nitrogen to room temperature. The absence of peaks in the scattering spectrum of $NH_4ClO_4$ suggests that the $NH_4$ groups have rotational freedom. In the scattering spectrum of $H_3OClO_4$, a peak is observed at 0.062 ev, which is considered to be due to hindered rotations of the $H_3O$ group. (auth)

**32169** A NEW METHOD OF DETERMINING THE MELTING POINT OF POWDERED MATERIALS BY ALPHA RAY ABSORPTION. Kobayashi, Hisanobu (Inst. of Physical and Chemical Research, Tokyo). Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 59: 1-4 (Mar. 1965).

This method is based on the principle that a sudden variation of α-ray absorption is caused by melting of powdered material: if the dotlike solid particles are melted and spread into a layer whose thickness is enough to cut off α rays, the cut-off area of an α source electroplated on the substrate will increase. The melting points of ice droplets and powdered benzene and p-xylene were

measured as examples. This finding suggests the possibility of measuring the melting points of other powdered materials by this method. (auth)

**32170** ELECTRON STRUCTURE AND PROPERTIES OF TRANSITION METAL HYDRIDES. Samsonov, G. V. (Inst. of Problems in Metallography, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 433-9(1965). (In Russian)

Chemical bonding in transition metal hydrides was studied considering the acceptor properties of the d-electron shell. It was found that the semiconducting properties of hydrides are developed by increased H:H bonding with strong Me:Me and weak Me–H bonding. An analysis of previous works indicated that the appearance of superconductivity is produced by stable $d^5$, $d^5s^2$ electron configurations. Such configurations form at the expense of hybridization in energetically closed states. For instance, for vanadium ($3d^34s^2$, T = 5.10°K), for niobium ($4d^4\,5s^1$, T = 9.17°K), for tantalum ($5d^3\,6s^2$, T = 4.40°K), and for technetium ($4d^6\,5s^1$, T = 8.24°K). It is postulated that the ability of H to transmit its 1s electron into d-sublevels vacancies in transition metals could be utilized in the preparation of complex carbohydride, hydronitride, and other phases. (R.V.J.)

**32171** ELECTRIC PROPERTIES OF $Sm_2S_3$. Lashkarov, G. V.; Paderno, Y. B.; Radzikovskaya, S. V.; Fedorchenko, V. P. (Inst. of Problems in Metallography, Kiev). Ukr. Fiz. Zh., 10: 520-4(May 1965). (In Ukrainian)

A procedure is described for obtaining compact samples of samarium sesquisulfide, and for measuring the thermal emf and the electric conductivity. These magnitudes were studied over a temperature range of 300–1300°K. It is shown that $Sm_2S_3$ is a refractory semiconductor with a width of the forbidden zone equal to 2.96 ev. The bond lengths, of Me–Me, Me–S and S–S were calculated in the known sesquisulfides $Me_2S_3$ of rare-earth metals having a structure of $Th_3P_4$ and in SmS, proceeding from the values of the ionic crystal radii. A comparison of the values obtained indicates strengthening of the covalent bonds S–S owing to weakening of the ionic bonds Me–S in the sesquisulfides of rare-earth metals and, consequently, indicates that the chemical bonds in these compounds are of an ionic-covalent nature. A comparison is made between the interatomic distances in SmS and $Sm_2S_3$ and their physical properties. A conclusion is drawn as to the absence of a quasi-extrinsic 4f level in $Sm_2S_3$ and the lesser width of the forbidden zone in this compound as compared with SmS. (auth)

**32172** INVESTIGATION OF $U_2O_5$. Kuzmicheva, E. U.; Rozanova, O. H.; Kovba, L. M.; Ippolitova, E. A. Vestn. Mosk. Univ., Ser. II, Khim., No. 2, 39-43(Mar.-Apr. 1965). (In Russian)

Studies were made of the preparation, structure, composition, and thermal stability of $U_2O_5$. (R.V.J.)

**32173** PRECIPITATION OF CALCIUM, STRONTIUM AND BARIUM URANATES. Bereznikova, I. A.; Ippolitova, E. A.; Kovba, L. M. Vestn. Mosk. Univ., Ser. II, Khim., No. 2, 44-6(Mar.-Apr. 1965). (In Russian)

Thermographic, thermogravimetric, and roentgenographic studies were made of dehydration processes in precipitated barium, calcium, and strontium uranates. (R.V.J.)

**32174** LIFETIME OF THE $^4F_{\frac{3}{2}}$ EXCITED STATE OF THE $Nd^{3+}$ ION IN $CaF_2$ AND $CaWO_4$. Kaminskii, A. A.; Kornienko, L. S.; Prokhorov, A. M. (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 1262-6(May 1965). (In Russian)

The lifetime of the $^4F_{\frac{3}{2}}$ excited state of the $Nd^{3+}$ ion in $CaF_2$ and $CaWO_4$ was investigated in a broad temperature range for $Nd^{3+}$ concentrations of the order of several thousandths percent to a few percent. The effect of radiationless transitions is analyzed. A simple taumeter is described. (auth)

**32175** DETERMINATION OF THE RELATIVE DIFFERENCES IN URANYL ION MOBILITY. Konstantinov, B. P.; Kaimakov, E. A.; Basargin, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Fiz. Khim., 39: 836-9(Apr. 1965). (In Russian)

Tests on the distribution of uranium isotopes by the method of ion mobility are described. The concentration dependence of the relative difference of the mobility of the isotopic uranyl ions was measured in aqueous solutions of $UO_2Cl_2$ at 60°C in the concentration range from 0.93 to 4.6M. For uranyl ions containing $^{238}U$ and $^{234}U$, the value of the relative difference of the mobility varied from $5 \times 10^{-6}$ to $9 \times 10^{-4}$. The concentration dependence is explained by the structural characteristics of the $UO_2Cl_2$ solution and the presence of isotopic exchange between different ionic states. (tr-auth)

**32176** A CELL FOR MEASURING THE ION MOBILITY BY MEANS OF RADIOACTIVE TRACERS. Shvedov, V. P.; Nichugovskii, N. F. (Leningrad Technological Inst.). Zh. Fiz. Khim., 39: 1030-2(Apr. 1965). (In Russian)

The cell has its capillary divided by means of a three-way stopcock into two sections. An electrode container is soldered at the end of the capillary. The cell is filled with the electrolyte to be investigated, and in one section the electrolyte with the addition of the radioactive isotope of the element being studied is introduced. By means of the movement of the boundary of the active solution under the influence of an electrical field, the activity in the adjacent section is increased. The activity induced in the adjacent section is measured. These measurements and knowledge of the initial activity in the first section makes it possible to calculate the distance through the boundary of the active solution. From this the mobility can be calculated, when the time and potential gradient are known. The mobility of $Cs^+$ ions in cesium iodide solutions and of $Ce^{3+}$ in potassium nitrate solutions at pH 3.0 and temperature of 18°C was determined. (tr-auth)

**32177** SOOSAZHDENIE I ADSORBTSIYA RADIOAKTIVNYKH ELEMENTOV. (Co-precipitation and Adsorption of Radioactive Elements). Vdovenko, V. M., ed. Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. 196p.

A collection of 33 original experimental and theoretical works on the processes of coprecipitation and adsorption of radioactive isotopes is presented. Abstracts were prepared for 25 of the papers. (J.S.R.)

*For abstracts of individual papers see: 32178, 32179, 32239, 32259, 32298, 32299, 32300, 32301, 32302, 32303, 32304, 32305, 32306, 32307, 32308, 32309, 32310, 32311, 32312, 32313, 32314, 32315, 32316, 32317, and 32318.*

**32178** COMPLEX FORMATION OF PROTACTINIUM WITH CHLORIDE AND SULFATE IONS BY SORPTION ON A SILICA GEL. Davydov, A. V.; Marov, I. N. p.134-9 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

It was found that in solutions with $[HNO_3] + [HCl] = 6M$ at concentrations of HCl < 4M, two chloride complexes are formed of the types 1:1 and 1:2 with stability constants $\beta_1 = 0.025$ and $\beta_2 = 0.069$. It was established that in 3 and 6M solutions of nitric acid, containing $1.5M(NH_4)_2SO_4$, sulfate complexes are formed with the ratio $Pa:SO_4^{2-} = 1:1$ for which the value $K_{f_1}$ equals 5.35 (for 3M $HNO_3$) and 2.5 (for 6M $HNO_3$). The mechanism of the sorption of protactinium on silica gel was considered. (tr-auth)

**32179** COMPLEX FORMATION OF TRIVALENT AMERICIUM WITH ACETATE IONS BY MEANS OF ION EXCHANGE. Lebedev, I. A.; Yakovlev, G. N. p.183-9 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The sorption of trace quantities of $Am^{3+}$ on Dowex cationite 50 × 8 was investigated as a function of the concentration of acetate ions. It was established that, at acetate ion concentrations from $1.4 \times 10^{-3}$ to 0.5M in solution, complex ions with the composition $AmAc^{2+}$ (Ac = acetate) and $Am(Ac)_2^+$ were present. The instability constants of americium acetate complexes at ion intensities of 0.2, 0.5, and

1.0 were calculated. By means of the extraction at zero ion intensity the thermodynamic instability constants for the ions $AmAc^{2+}$ and $Am(Ac)_2^+$ were calculated as $1.2 \times 10^{-3}$ and $6.4 \times 10^{-3}$. (tr-auth)

**32180** IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF URANIUM DIOXIDE. Blundell, Anthony; Brooks, Lionel Hepworth; Clarke, John Colin; Gillies, George Marshall; Saum, Christopher John (to United Kingdom Atomic Energy Authority). British Patent 979,351. Jan. 1, 1965. Filed Jan. 23, 1961.

A method is described for manufacturing $UO_2$ by converting $UF_6$ to $UO_2F_2$ using steam at a temperature of at least 130°C in the presence of a continuous flow of a gas inert to this conversion. The volume ratio of inert gas to $UF_6$ is 6 to 1. The resulting $UO_2F_2$ powder has a surface area in the range of 3 to 12 $m^2/g$, and the $UO_2F_2$ subsequently is converted to $UO_2$ using $H_2$ and steam at a temperature of 550 to 600°C. The $H_2$ to steam volume ratio for the conversion to $UO_2$ is at least 2 to 1. (B.L.M.)

**32181** IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANIUM DIOXIDE. Lloyd, James Elgie; Brooks, Lionel Hepworth (to United Kingdom Atomic Energy Authority). British Patent 979,544. Jan. 6, 1965. Filed June 13, 1961.

A method for producing $UO_2$ having a high reactivity toward HF includes hydrating $UO_3$ by mixing it in powder form at 80°C with an amount of water slightly in excess of the stoichiometric amount required for forming the dihydrate. The high speed mixing is carried out for about 20 min to bring the water into intimate contact with the particles of $UO_3$. The resulting paste is dried and aged for about 1 hour to produce a dry granular solid of hydrated $UO_3$. The hydrated $UO_3$ thus produced is of low bulk density and on dehydration by $N_2$ and reduction by $H_2$ yields a $UO_2$ that is highly reactive to hydrofluorination. (B.L.M.)

**32182** IMPROVEMENTS IN OR RELATING TO RARE EARTH MANGANITE MONOCRYSTALS. Bertaut, Erwin Felix; Forrat, Francis (to Commissariat à l'Énergie Atomique). British Patent 979,546. Jan. 6, 1965. Priority date June 12, 1961, France.

A method is described for the preparation of monocrystals of rare earth manganites grown parallel to the base planes. The crystals may have interesting piezoelectric and ferroelectric properties and a very high resistivity. A solution of a rare earth oxide and MnO in molten $Bi_2O_3$ at 1350°C is supersaturated by slow evaporation of $Bi_2O_3$ at 1400°C, cooled at a rate of 10°C/hr to ambient temperature, and rare earth manganite monocrystals are separated. (B.L.M)

**32183** PRODUCTION OF URANIUM AND PLUTONIUM MONOCARBIDE. Sowden, Ronald George (to United Kingdom Atomic Energy Authority). U. S. Patent 3,166,515. Jan. 19, 1965. Priority date Dec. 2, 1960, Great Britain.

A process is reported for the preparation of uranium monocarbide and mixtures of uranium monocarbide with up to 30 mole % plutonium monocarbide that are useful reactor fuel materials. The uranium oxide or mixtures of uranium oxide with plutonium oxide are reacted with stoichiometric proportions of elemental carbon at a temperature not to exceed 1500°C while the pressure is maintained at < 200 $\mu$ of Hg over the reactants with continuous removal of the gaseous products of reaction. The mixed oxides for the preparation of the monocarbides may be obtained by co-precipitating the mixed oxalates containing not more than 30 mole % of plutonium oxalate from an aqueous solution, calcining the mixed oxalates, and reducing the calcined oxalates to form an intimate mixture of the dioxides. (B.L.M.)

**32184** URANIUM PROCESSING. Reese, Stanton L.; Runion, Thomas C. (to W. R. Grace and Co.). U. S. Patent 3,168,369. Feb. 2, 1965. Filed Dec. 18, 1961.

A dry process for the conversion of $UF_6$ to $UO_2$, or $U_3O_8$ permits greater concentrations of $^{235}U$ to be handled with safety. The reaction of $UF_6$ with dry steam at 230–350°F produces $UO_2F_2$ in the form of a fine dry powder. Treatment of the $UO_2F_2$ at 800–1000°F in the presence of steam and the absence of air produces $UO_3$. Treatment of the $UO_2F_2$ at 1000–1800°F in the presence of steam and air produces $U_3O_8$. Treatment of the $UO_2F_2$ with hydrogen at 1000–1400°F produces $UO_2$. The fluoride content of the $UO_2$ can be reduced by a small quantity of steam in the reactant gas. (A.G.W.)

**32185** PROCESS FOR PRODUCING HIGH DENSITY URANIA FUEL ELEMENTS. St. Pierre, Philippe D. S. (to General Electric Co.). U. S. Patent 3,168,371. Feb. 2, 1965. Filed Oct. 28, 1960.

In a process for producing high-density $UO_2$ particles, ammonium diuranate is first compacted at pressures of ½–10 tsi to form a green compact. The compact is heated in a reducing atmosphere to about 500°C to reduce the ammonium diuranate to $UO_2$. The heating is performed at a rate such that the compact breaks into fragments because of internal stresses. The resulting particles are then sintered to attain maximum density. (A.G.W.)

**32186** COLUMN DISSOLVER. Sands, A. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,195,984. July 20, 1965.

A system for dissolving particulate solids, which comprises a series of interconnected vertically disposed tubular columns, is described. The columns are so arranged that solids and fluids move through the system without the aid of pumps. (AEC)

## Organic Chemistry

*Refer also to abstract 32122.*

**32187** (K-1635) CALCULATION OF THE DENSITY AND VISCOSITY OF SUCROSE SOLUTIONS. Barber, E. J. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 24, 1965. Contract W-7405-eng-26. 43p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

In the application of the zonal ultracentrifuge to separation of biological materials, sucrose solutions are often used to produce the gradient through which the biological materials sediment. Equations have been developed which permit the calculation of the density and viscosity of sucrose solutions as functions of the composition for use in computer programming of the calculation of sedimentation coefficients. A 9-constant empirical equation expressing the density as a function of the weight fraction sucrose and the temperature is recommended for the temperature range of 0 to 30°C and a concentration range of 0 to 75 per cent sucrose. For use in the calculation of density between 30 and 60°C and from 0 to 70 weight per cent sucrose, a theoretically based empirical equation with six adjustable constants is recommended. The former equation reproduces the National Bureau of Standards density data to 7 parts in 10,000 and the latter equation reproduces them within 4 parts per thousand. An Antoine or modified Arrhenius equation was used to correlate the viscosity data of the National Bureau of Standards as a function of the mole fraction sucrose over the temperature range of 0 to 80°C and the concentration range from 0 to 75 weight per cent sucrose. Over the whole set of tabulated data fitted, the standard deviation from the tabulated data was 2 parts per thousand with a few individual values deviating by as much as 8 parts per thousand. In the range of maximum interest from 5 to 40°C and 5 to 40 weight per cent sucrose, no calculated value differed from the tabulated data by more than 3 parts per thousand. (auth)

**32188** (UJV-1118/64) PREPARATION OF MUSTARD GAS—$S^{35}$. Kronrad, L. (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). Jan. 1965. 5p. Dep.(mn).

A method is given for the preparation of $\beta,\beta'$-dichlorodiethyl sulfide-$^{35}S$ in high yield and with reduced preparation time. $Na_2{}^{35}S \cdot 9H_2O$ is reacted with ethylene chlorhydrin to form $\beta,\beta'$-thiodiglycol-$^{35}S$, which is then reacted

with thionyl chloride to give mustard gas-$^{35}S$. The specific activity is in the range 5 to 30 mC/mM. Decontamination of equipment is discussed. (D.L.C.)

**32189** ROTATIONAL DYNAMICS OF SOLID METHANE MOLECULES BY SLOW NEUTRON CROSS-SECTION MEASUREMENTS. Rogalska, Zofia (Inst. of Nuclear Physics, Krakow). Acta Phys. Polon., 27: 581-6(Apr. 1965).

The inelastic scattering of subthermal neutrons by molecules of liquid methane and—in the same neutron energy region—of solid methane, was studied. Comparison of the slopes of the two curves representing the total scattering cross section as a function of the neutron wavelength leads to the conclusion that in solid methane—at least near the melting point—molecular rotation is probably free or almost free. (auth)

**32190** INTERACTION OF BOVINE AUTOPROTHROMBIN C WITH PHOSPHOLIPIDS AND DIVALENT CATIONS. Cole, Edmond R.; Koppel, J. L.; Olwin, John H. (Presbyterian-St. Luke's Hospital, Chicago). Can. J. Biochem., 42: 1595-1603(Nov. 1964).

As part of a study of complexes formed by the thromboplastic enzyme, autoprothrombin C, with phospholipids and cations, the ability of Sr to act as a cation cofactor for the enzyme was demonstrated. Autoprothrombin C could be complexed to different phospholipids and removed from solution in the form of such complexes. A technique for dissociating these complexes was developed, resulting in the recovery of the thromboplastic enzyme essentially free of phospholipid and in a higher degree of purity. Calcium ions are required for the formation of the complex, but Sr can replace Ca not only as the metal ion in the phospholipid-complexing system, but also as an autoprothrombin C cofactor in a prothrombin activation mixture. Unlike Sr, Mg was not effective in either system. Thus, it was shown that if Ca is omitted from the prothrombin activation mixture, thrombin activity does not develop. Likewise, under conditions where 98% of autoprothrombin C is complexed and removed from solution in the presence of Ca, all of the autoprothrombin C in the supernatant could be accounted for when Ca was omitted from the complexing mixture. Assay of the precipitate also showed no prothrombin-converting activity. Over 90% of autoprothrombin C was complexed when Sr replaced Ca in the complexing mixture, but Mg complexed only 3%. There was good correlation between these results and the ability of Ca, Sr, and Mg to serve as the cation cofactor for autoprothrombin C in an activation mixture composed of 0.4 ml of bovine prothrombin (1800 units), 0.3 ml of 1:50 diluted adsorbed beef serum, 0.2 ml of 0.4% asolectin emulsion, 0.2 ml of autoprothrombin C (6.3 units), and 0.1 ml of a 0.32 M solution of the cation in imidazole buffer. The role of different phospholipids in the complexing phenomenon was also studied and compared with the suitability of the same phospholipids as prothrombin-activating cofactors of autoprothrombin C. (BBB)

**32191** NUCLEAR SPIN RELAXATION IN LIQUID AND SOLID METHANE: ISOTOPE EFFECTS. De Wit, Gerald A.; Bloom, Myer (Univ. of British Columbia, Vancouver). Can. J. Phys., 43: 986-1000(June 1965).

The deuteron spin-lattice relaxation time $T_1$ and spin-spin relaxation time $T_2$ were studied in $CD_4$ and $CD_3H$ between 55 and 110°K. $T_1$ was found to increase very slowly with temperature over the entire temperature range for $CD_4$ with no measurable change being observable at the melting point. Since the deuteron spin relaxation is produced by intramolecular quadrupolar interactions, these results are in strong disagreement with the Debye rotational diffusion model often used to describe molecular reorientation. These results were used to reanalyze the proton $T_1$ data for $CH_{4-n}D_n$ previously given by Bloom and Sandhu. The contributions to $T_1$ from intermolecular dipolar interactions were found to be in close agreement with theory. Contributions from the spin-rotation interaction were found to be extremely small or zero in this temperature range. The effects of translational diffusion on the proton and deuteron $T_1$ and $T_2$ just below the melting point are also discussed. (auth)

**32192** STUDY ON $N^{15}$-H SPIN-SPIN COUPLING OF 4-NITROQUINOLINE 1-OXIDES CONTAINING DEUTERIUM AND/OR NITROGEN-15. Kawazoe, Yutaka; Ohnishi, Masako; Kataoka, Nobuko (National Cancer Research Inst., Tokyo). Chem. Pharm. Bull. (Tokyo), 13: 396-7 (Mar. 1965).

The spin-spin interactions of aromatic ring protons with the nitrogen contained in an aromatic ring or a nitro group using $^{15}N$-substituted quinoline 1-oxide and 4-nitroquinoline 1-oxides are reported. The syntheses of these $^{15}N$ compounds were carried out starting with nitration of benzene (for 1-$^{15}N$ compounds) or quinoline 1-oxide (for 4-$^{15}NO_2$ compounds) with potassium nitrate-$^{15}N$. The assignment of the signals was made by comparison of the spectra of deuterated quinoline 1-oxides and deuterated 4-nitroquinoline 1-oxide in which deuterium was substituted at various positions and in different degrees. The results showed that $J_{^{15}N,3\text{-H}}$ is larger than $J_{^{15}N,2\text{-H}}$ and that $J_{^{15}N,8\text{-H}}$ is clearly observable: $J_{1\text{-}^{15}N,3\text{-H}} = 5.1$, $J_{^{15}NO_2,3\text{-H}} = 2.5$, $J_{1\text{-}^{15}N,8\text{-H}} = 1\text{-}2$, and $J_{1\text{-}^{15}N,2\text{-H}} = <1$ cps. Observable coupling occurred with the protons on $\beta$ carbons but not with those on $\alpha$ carbons directly attached to the nitrogen concerned, and the coupling constant between 1-$^{15}N$ and 3-H was twice as large as that between $^{15}NO_2$ and 3-H. This difference in magnitude might be explained by the fact that the 1-$^{15}N$ and 3-H are in the trans configuration with respect to the 2-C and 3-C bond, while 4-$^{15}NO_2$ and 3-H are in the cis configuration to the 3-C and 4-C bond, and 1-$^{15}N$ and 8-H are also cis to the 9-C and 8-C bond. Alternatively, it might be due to the difference in the electronic structure between nitro and aromatic basic nitrogens. (BBB)

**32193** ISOTOPIC EXCHANGE OF HYDROGEN IN HYDROCARBONS ON THE RARE-EARTH OXIDES. 3. THE STUDY OF DEUTERIUM EXCHANGE REACTION BETWEEN HYDROCARBONS ON GADOLINIUM OXIDE. Minachev, Kh. M.; Vakk, E. G.; Dmitriev, R. V.; Nasedkin, E. A.; Fedyunin, Yu. A. (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 4, 618-25(1965). (In Russian)

The exchange of one atom of hydrogen per one adsorption stage appeared with the primary exchange process in the hydrocarbons investigated (among them cyclohexenes at temperatures above 420°C). At optimum exchange velocity for this process exponential decreases of the concentration correlated with increases of the hydrogen atoms on distribution curves. The exchange of several hydrogen atoms per one adsorption stage appeared in secondary processes. The total yields of products of the multiple exchanges did not exceed tenths and hundredths parts of one percent. The presence in the hydrocarbon molecule of double and aromatic bonds sharply increased the velocity of the exchange. In the case of aromatic hydrocarbons the increases of the exchange velocity reaches equilibrium with the order of distribution of exchange products. The velocity of the exchange of hydrogen on primary atoms of carbon was higher than on secondary carbon atoms. (tr-auth)

**32194** THE EXCHANGE LABELING OF KETO STEROIDS WITH TRITIUM BY ADSORPTION CHROMATOGRAPHY ON BASIC ALUMINA. Klein, Peter D.; Knight, John C. (Argonne National Lab., Ill.). J. Am. Chem. Soc., 87: 2657-61(June 20, 1965).

Keto steroids may be labeled with tritium by chromatography on basic alumina treated with tritiated water. The tritium is not removed by recrystallization in hydroxylic solvents but 95% can be back-exchanged under strongly basic conditions. Reduction of the keto steroids with lithium aluminum hydride occurred without loss of label and provided the corresponding alcohols in which the tritium was no longer exchangeable. The method provided pure, highly labeled products with remarkable economy of tracer. (auth)

**32195** DEUTERIUM-HYDROGEN EXCHANGE IN AMIDE N-H GROUPS. Klotz, Irving M.; Frank, Bruce H.

(Northwestern Univ., Evanston, Ill.). J. Am. Chem. Soc., 87: 2721-8(June 20, 1965).

Rates of deuterium-hydrogen exchange in proteins reflect the structure and conformation of these macromolecules in ways that are still obscure. It seemed pertinent, therefore, to examine rates of N – H → N – D exchange in a model peptide system, $CH_3CONHCH_3$. The kinetics were followed in dioxane–water and in pure water solutions, as well as in the liquid amide. Catalysis was produced not only by $H^+$ and $OH^-$ but also by a number of acids (e.g., formic, acetic) and bases (e.g., imidazole, amines). Activation energies (about 20 kcal) for exchange in the amide when it was definitely monomeric in water were comparable in magnitude to those reported for slowly exchanging hydrogens in proteins. All these observations made it unlikely that slowly exchanging hydrogens in proteins represent a measure of helically bonded ones. (auth)

**32196** POLYMORPHISM IN GADOLINIUM TRICHLORIDE. **Harris, A. L.; Veale, C. R. (National Chemical Lab., Teddington, Middx., Eng.).** J. Inorg. Nucl. Chem., 27: 1437-9(June 1965).

It is shown that gadolinium trichloride exhibits polymorphism. In addition to the $UCl_3^-$ type structure common to the lighter lanthanide trichlorides, a low-temperature $PuBr_3$ structure stable below about 100°C was found. (M.C.G.)

**32197** A METHOD FOR RAPID MICROSYNTHESIS OF RADIOACTIVE CHOLESTEROL ESTERS. Pinter, Karoly G.; Hamilton, James G.; Muldrey, James E. (Tulane Univ., New Orleans). J. Lipid Res., 5: 273-4(Apr. 1964).

A simple method for synthesizing esters of $^{14}C$-labeled cholesterol of high specific activity is described. The formation of acyl chlorides requires only 10 min and they are reacted with labeled cholesterol to form the cholesterol esters in another 5 min. Yields were 30 to 70% and radiopurities of 90 to 99.5% were achieved. The acyl chlorides of palmitic, stearic, oleic, linoleic, linolenic, and arachidonic acids were prepared as follows. The fatty acid (1 mmole) was placed in a side-arm flask and oxalyl chloride then added in ~3-fold M excess. The flask was evacuated and placed in a water bath at 65°C and the mixture boiled for 5 min to drive off excess oxalyl chloride. Conversion of fatty acids to acyl chlorides at this point was 30 to 45%, and after addition of another 3-fold M excess of oxalyl chloride and repetition of the procedure the yield was raised to 75 to 85%. Cholesterol-4-$^{14}C$ (5 to 50 μmoles) dissolved in 5 ml dry diisopropyl ether was added to the acyl chloride; the mixture was placed under vacuum at 60°C and boiled slowly to remove the solvent, completing the esterification of the cholesterol-4-$^{14}C$ with the fatty acid. Each labeled cholesterol ester was chromatographed on silica gel-impregnated glass fiber paper in isooctane (2,2,4-trimethylpentane), together with the corresponding nonradioactive cholesterol esters as markers; their $R_F$ values were recorded. The hexane solution of the reaction mixture containing cholesterol, cholesterol ester, and acyl chloride was transferred to a silicic acid column and eluted with hexane-benzene, 100:15. The column effluent was collected in 20-ml portions; an aliquot of each fraction was chromatographed on glass paper and the distribution of radioactivity was determined. Any unreacted cholesterol-4-$^{14}C$ could be readily recovered from the columns for future use. The cholesterol ester could also be readily purified by thin-layer chromatography. The described method probably could also be adapted for the synthesis of cholesterol esters labeled in the fatty acids. (BBB)

**32198** OPTICAL ROTATORY DISPERSION OF SOME DEUTERIUM COMPOUNDS. Streitwieser, Andrew, Jr.; Verbit, Lawrence; Andreades, Sam (Univ. of California, Berkeley). J. Org. Chem., 30: 2078-9(June 1965).

Earlier work on optical rotatory dispersion of deuterium-labeled compounds was done at selective wavelengths from 650 down to 400 mμ. The long path lengths required precluded accurate work at shorter wavelengths. A number of samples was examined with a recording spectropolarimeter, which allowed a direct measurement of the optical rotatory dispersion curves of several deuterated compounds well into the ultraviolet. On the most sensitive mode, the instrument had a precision of ±0.0002°. Zero readings were obtained using the corresponding undeuterated and inactive compounds. The results of the work confirmed that deuterium behaves as an ordinary substituent so far as optical activity was concerned. (F.J.H.)

**32199** CATALYTIC DEUTERIUM-EXCHANGE REACTIONS WITH ORGANICS. XIX. Pi-COMPLEX ADSORPTION IN THE EXCHANGE OF THE ALKYLBENZENES. Garnett, J. L.; Sollich-Baumgartner, W. A. (Univ. of New South Wales, Kensington, Australia). J. Phys. Chem., 69: 1850-8(June 1965).

A theory for the π-complex adsorption of aromatic molecules on transition metal catalysts was developed. The importance of this mode of interaction both on reagent displacement effects and the activation energy in C–H bond rupture is discussed. Two mechanisms, termed the associative π-complex substitution mechanisms, were proposed. The latter mechanism was of major importance in heavy water-aromatic exchange and had certain advantages in the interpretation of these reactions when compared with conventional associative and dissociative mechanisms. The concept of π-complex adsorption was evaluated using data from the deuteration of alkylbenzenes. Consistent with π-complex adsorption, alkylbenzenes adsorbed less strongly than most polycyclic aromatics. Adsorption strength decreased with increasing bulk and increasing symmetry of the methyl substituent. Orientation effects, trends in exchange rates of unhindered ring positions, and comparative rates of aromatic and aliphatic hydrogen exchange in the alkylbenzenes confirmed the relative importance of the dissociative π–complex substitution mechanism. (auth)

**32200** ABSTRACTION REACTIONS OF HYDROGEN AND DEUTERIUM ATOMS: MERCURY-PHOTOSENSITIZED DECOMPOSITION OF MIXTURES OF CYCLOHEXANE AND CYCLOHEXANE-$d_{12}$. **Hentz, Robert R.; Chang, Joseph Y.; Burton, Milton (Univ. of Notre Dame, Ind.).** J. Phys. Chem., 69: 2027-33(June 1965).

Hg-photosensitized decomposition of mixtures of cyclohexane and cyclohexane-$d_{12}$ yielded information regarding isotope effects in the primary process and in abstraction reactions of H and D atoms acting on $C_6H_{12}$ and $C_6D_{12}$. At 12°C in the gas phase, production of the H atom was ~13 times more probable than production of the D atom, and abstraction of the H atom was ~16 times as probable as abstraction of the D atom. A defined parameter $f \equiv (\text{HD yield})^2/(\text{H}_2 \text{ yield})(\text{D}_2 \text{ yield})$ was shown to be ≳4 in the gas phase, as expected from theoretical consideration of purely atomic abstraction reactions, but <4 in liquid phase photosensitization and radiolysis. The latter result may be ascribed to some "molecular decomposition" in radiolysis, but a more realistic view with respect to photosensitization is that possible cage effects in the liquid phase (perhaps involving short-lived HgH) so affect the probability of reaction of the H (or D) atom with its sibling radical that a distinction from molecular decomposition is largely semantic. (auth)

**32201** CONVENIENT LABELLING TECHNIQUE FOR MASS SPECTROMETRY: ACID-CATALYZED DEUTERIUM AND OXYGEN-18 EXCHANGE VIA GAS-LIQUID CHROMATOGRAPHY. Richter, Wilhelm J.; Senn, Martin; Burlingame, A. L. (Univ. of California, Berkeley). Tetrahedron Letters, No. 17, 1235-9(May 1965).

The exchange of enolizable hydrogen for deuterium by a single passage of sample through a predeuterated alkaline GLC (gas-liquid chromatographic) column was demonstrated. The average isotopic purity of the resulting labeled ketones was shown to be 96% by mass spectrometric analysis. Amides, aldehydes, and esters displayed less satisfactory results. Acidic exchange conditions on a tandem GLC column were employed and the scope of ap-

plicability of the GLC labeling method was extended in several important aspects. Ketones which incorporated an average of 96% D under alkaline conditions, exchanged with analogous ease under the prescribed acidic conditions. Seventeen compounds were chromatographed; in each case a single passage of sample through the column was performed and the collected sample analyzed mass spectrometrically. Carbonyl compounds, which were precluded previously by the nature of additional acidic functionality, e.g. carboxyl and phenolic hydroxyl groups, showed essentially quantitative uptake of D under acidic conditions. Also the exchange of polyfunctional compounds containing easily saponifiable groups and/or alkali reactive functions, e.g. keto esters and aldehydes, respectively, were labeled satisfactorily. In addition to the augmented scope for D labeling, the acidic medium allowed extension of this method to $^{18}O$ labeling for the same compounds. D and $^{18}O$ incorporation were compared. Molecules, which undergo reaction under acidic conditions to yield acidic functional groups, e.g. acid chlorides and anhydrides, can incorporate $^{18}O$ in the process. As demonstrated by the $^{18}O$ data shown, the effectiveness of the oxygen labeling is satisfactory. The ease and rapidity with which exchange of enolizable H's and carbonyl O's can be quantitatively achieved emphasize the practical utility of the tandem GLC column. The method is well suited for the preparation of labeled samples of synthetic and natural products available in only minute amounts. (BBB)

**32202** PHENYLCHLOROPHENYL POLYSILOXANES. (to General Electric Co.). British Patent 980,104. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

A method is described for the preparation and polymerization of a class of polydiorganosiloxanes containing both Si-bonded phenyl groups and Si-bonded chlorophenyl groups. The polymerized material has the recurring structural units: $-(C_6H_5)_2Si[O-(C_6H_5)_2Si]_nO-(C_6H_5)_2Si-O-Si(C_6H_5)_x(C_6H_4Cl)_{2-x}-O-$. The polymeric diorganosiloxane is a hard brittle polymer at room temperature and a viscous moldable gum at 50 to 100°C. Crosslinking of the polymers can be effected to produce silicone rubbers. (B.L.M.)

**32203** PHENYLVINYLPOLYSILOXANES. (to General Electric Co.). British Patent 980,105. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

The method described previously was applied to the preparation and polymerization of phenylvinylpolysiloxanes. The cyclopolysiloxanes can be polymerized to provide linear organopolysiloxanes consisting essentially of the recurring unit: $-(C_6H_5)_2Si[O-(C_6H_5)_2Si]_nO-(C_6H_5)_2Si-O-(C_6H_5)(CH_2=CH)Si-O-$. The presence of the Si-bonded vinyl group in the polymers and copolymers facilitates a cure of these materials so that cure is effected much more readily than in the case of polymeric materials that do not contain the Si-bonded vinyl groups and in which most of the organic substitutents are aryl radicals such as phenyl groups. These linear organopolysiloxanes can be crosslinked to form silicone rubbers. (B.L.M.)

**32204** NITRILE-CONTAINING POLYSILOXANES. (to General Electric Co.). British Patent 980,108. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

The method previously described was applied to the preparation and polymerization of nitrile-containing polysiloxanes. The nitrile radical is attached to Si through at least two C atoms. These nitrile-containing polysiloxanes can be polymerized to homopolymers or polymerized with other cyclic polydiorganosiloxanes to form copolymers. The silicone rubbers prepared from the homopolymers have good elongation and high tensile strengths from 500 to 2000 psi. (B.L.M.)

**32205** METHYLPHENYLPOLYSILOXANES. (to General Electric Co.). British Patent 980,107. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

The method previously described was applied to the preparation and polymerization of methylphenylpolysiloxanes. These cyclopolysiloxanes can be polymerized to provide linear polydiorganosiloxanes or can be copolymerized with other cyclic polydiorganosiloxanes to form a number of copolymers. Crosslinking of the polymers and copolymers yield silicone rubbers that are suitable for use as gaskets for automotive transmissions, oven door seals, and insulation for electrical conductors. (B.L.M.)

**32206** METHYLVINYLPOLYSILOXANES. (to General Electric Co.). British Patent 980,106. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

The method previously described was applied to the preparation and polymerization of methylvinylpolysiloxanes. These siloxanes polymerize to high molecular weight polymers with a high percentage of Si-bonded phenyl groups but are readily curable to the solid, elastic state by silicone rubber curing catalysts. (B.L.M.)

# Radiation Chemistry

## *See also* BIOLOGY AND MEDICINE — Radiation Effects.

*Refer also to abstracts 32042, 32065, 32642, 32836, 33285, and 33524.*

**32207** (AECL-2260) THE RANGE OF REACTIVITY TRANSFER IN THE RADIOLYSIS OF SOLID HYDROCARBON MIXTURES. Dyne, P. J.; Denhartog, J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1965. 9p. $0.20(AECL).

Direct measurements were made of the range of excitation transfer in the radiolysis of deuterated cyclohexane $C_6D_{12}$. In the measurements, thin layers of $C_6D_{12}$ were sandwiched between thick layers of $CCl_4$, $C_6H_{12}$, and $C_6H_{14}$, and the sandwiches were irradiated with $^{60}Co$ gamma rays at 77°K. The amount and isotopic composition of the radiolytic hydrogen were determined, and from plots of G vs thickness, ranges of interaction between the layers were estimated. It is concluded that two processes were observed: one with a long average range (~200 A), probably the range of the electrons formed in the initial ionization of the hydrocarbon, and one with a much shorter range, an interaction between nearest neighbors. A third unidentified process gives HD by a bimolecular reaction and has a range of ~80 A. (D.L.C.)

**32208** (MIT-334-11) THE NATURE OF THE HIGH BOILER DEGRADATION PRODUCTS FROM IRRADIATED SANTOWAX OMP. Bley, W. N; Mason, E. A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Feb. 1, 1965. Contract AT(38-1)-334. 102p. (MITNE-55). Dep.; $4.00(cy), 2(mn) CFSTI.

Santowax OMP was irradiated in the M.I.T. research reactor under steady-state composition conditions at in-pile temperatures of 610 and 750°F. The high boiler (HB) content was maintained constant at approximately 33 wt % by distillation and recycle. HB samples removed from the loop from the beginning and end of the steady-state irradiations were fractioned by subliming the vapors evaporated from the HB in the liquid state. The fractions were compared in regard to number average molecular weights ($MW_N$) and the compositions qualitatively compared by high temperature gas chromatography. The analyses indicated that equilibrium HB composition had been achieved. The equilibrium values of $MW_N$ for the HB from the 610 and 750°F irradiations were 700 ± 35 and 580 ± 25 respectively. The sublimation yields for the 750°F HB indicated that "thermal cracking" and/or pyrolysis is an important process in the radiolysis of Santowax OMP. (auth)

**32209** ABSORPTION SPECTRA OF NEUTRON IRRADIATED ZnS SINGLE CRYSTAL. Seiyama, Takeyoshi; Yoshida, Toshio (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 66-7(Mar. 1965).

The optical transmissions in ZnS are affected by neutron

irradiation. The absorption near the fundamental edge is increased and drops off gradually toward longer wavelengths. Two absorption bands with peaks at 540 and 425 mμ are produced by neutron irradiation. These bands are increased by uv illumination and optical bleaching. (auth)

**32210** ESR OF FAST NEUTRON IRRADIATED ZnS. Shono, Yoshihiko; Yoshida, Toshio (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 68-9(Mar. 1965).

The asymmetry and the annealing effects on the line shape and the quenching spectra of ESR signal, g = 2.0027, observed in fast-neutron-irradiated ZnS crystals were investigated. The asymmetry of the signal is considered to result from either the intrinsic disorder of the crystal structure or the microscopic inhomogeneities produced by neutron irradiation. The ESR signal was annealed at 550°C. The line shape did not change in any stage of annealing below 550°C. The quenching peak at 5,700 Å was annealed at 450°C while the quenching peak of 4,500 Å was observed as long as the ESR signal was detected. It is considered that electrons released into the conduction band by illumination by 5,700 Å light recombine with holes responsible for the ESR signal. The problem of what electronic process occurs upon illumination by 4,500 Å light is still open. (auth)

**32211** ELECTRON BOMBARDMENT OF CdS SINGLE CRYSTALS. Kitagawa, Michiharu (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 73-5(Mar. 1965).

Spectral response of photoconductivity, temperature dependence of dark conductivity, and temperature dependence of photoconductivity in cadmium sulfide were measured before and after bombardment by $4 \times 10^{15}$ electrons/cm$^2$ at an energy of 2 Mev at 77°K. After bombardment, remarkable photosensitivity appeared at 600 mμ. The net donor level is introduced at 0.25 ev below the bottom of the conduction band by irradiation in the crystal, which has a donor level at 0.43 ev before irradiation. Temperature dependence of photoconductivity indicates that the induced sensitizing center having an energy level at 0.2 ev above the top of the valence band is annealed at room temperature. (auth)

**32212** ABSENCE OF EFFECT OF LIGHT ON THE REVERSION OF THE UV-INDUCED SPECTRAL ALTERATION OF CYTIDYLIC ACID. Kaplan, R. W. (Universitaet, Frankfurt am Main). Arch. Mikrobiol., 47: 379-81 (Mar. 24, 1964). (In German)

Irradiation of cytidylic acid with uv light altered the absorption peak from 270 to 237 mμ, presumably by introduction of water into the 5-6 double bond of the pyrimidine ring of cytosine. After a few hours at room temperature the absorption of irradiated cytidylic acid reverted to the original peak. The possibility that this might be related in part to mutations induced by uv irradiation because of production of cytosine hydrate in deoxyribonucleic acid was investigated further. The absorption spectrum of cytidylic acid solutions irradiated for 90 min and stored for 2, 4, or 8 hr in darkness and in visible light was studied. The experimental conditions were closely controlled as to period of uv irradiation, purity of cytidylic acid used, type of buffer, solution volumes, temperature, etc. There was no detectable effect observed on the absorption spectrum. Post incubation at ~25°C with and without light only resulted in a substance with the absorption spectrum of cytidylic acid. (BBB)

**32213** A VERSATILE RADIATION SOURCE FOR STUDYING GAMMA-INITIATED REACTIONS. Hodgins, J. W.; Werezak, G. N.; Ross, S. L. (McMaster Univ., Hamilton, Ont.). Can. J. Chem. Eng., 43: 117-19(June 1965).

Chemical reactions initiated by ionizing radiation were investigated. A gamma source was constructed employing $^{60}$Co as the emitter. This source was used in a radiation laboratory equipped with manipulators and therefore had a wide range of applicability. Dose rate, total dosage, and radiation environment can be varied for either batch or flow type experiments. The design and flux characteristics of this source are described. (auth)

**32214** WALL EFFECTS IN GAS-PHASE RECOIL TRITIUM CHEMISTRY. Urch, D. S.; Welch, M. J. (Queen Mary Coll., London). Chem. Commun., No. 7, 126-7 (Apr. 14, 1965).

When recoil tritium [$^3$He(n,p)$^3$H] reacts with ethane, either at low pressures or in sample tubes packed with quartz wool, a large increase in the relative amount of HT was observed, suggestive of a wall effect. To find the source of this excess of HT tubes were irradiated, which contained pure $C_2D_6$, oxygen, and $^3$He at low pressures and at high moderator concentrations. Using an eight-foot activated alumino column (–196°C) to separate HT and DT, it was found that a large percentage of the tritiated hydrogen was HT and not DT. At low pressure the DT/$C_2D_5T$ ratio was still higher than at high pressures. This might be due to recoil tritium atoms reacting with deuterated fragments that become adsorbed on the surface of the quartz during the reaction. (F.J.H.)

**32215** ON THE KINETICS OF FREE RADICAL ACCUMULATION IN RADIOLYSIS OF SOLIDS. Tikhomirov, L. A.; Belyaeva, V. A.; Buben, N. Ya. (Inst. of Chemical Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 4, 594-8(1965). (In Russian)

The concentrations found for alcohol radicals in crystalline solvates exposed to irradiation did not depend on the radiation dose output and slowly decrease with temperature. The radicals disappeared by first-order reactions with a constant speed, proportional to the dose output. The temperature dependence of the constants did not obey the Arrhenius law. An hypothesis on the intrinsic role of the radioinduced destruction of the radicals was expressed, and the irregularity of their distribution in solids in accumulation processes was assumed. (tr-auth)

**32216** p-NITROSODIMETHYLANILINE AS AN OH RADICAL SCAVENGER IN RADIATION CHEMISTRY. Kraljic, I.; Trumbore, C. N. (Univ. of Delaware, Newark). J. Am. Chem. Soc., 87: 2547-50(June 20, 1965). (TID-21779)

A method for the determination of relative rate constants for reactions with OH radicals based on the radiolysis of air-saturated solutions of p-nitrosodimethylaniline (RNO) is described. When 4 or $5 \times 10^{-5}$ M solutions of RNO at pH 9 were irradiated with $^{60}$Co γ rays in the presence of OH scavengers, the bleaching of the RNO chromophoric group was reduced. The experimental evidence reported demonstrated that at pH 9 the method was specific for OH radicals. Simple competition kinetics were obtained in competition studies for OH radicals with $Br^-$, $I^-$, $NO_2^-$, $H_3^-$, $CH_3COO^-$, $CH_3OH$, $C_2H_5OH$, and other ions and compounds, and their relative rate constants were reported. The results compared favorably with other recent published values based on competition kinetics as well as measurements of absolute rate constants by the electron-pulse technique. (auth)

**32217** ELECTRON AND ENERGY TRANSFER IN IRRADIATED XENON–HEXANE LIQUID SOLUTIONS. Davis, Donald R. (Univ. of California, Los Angeles); Libby, W. F.; Kevan, Larry. J. Am. Chem. Soc., 87: 2766-7(June 20, 1965).

The dimer and hexene yields in $^{60}$Co γ-irradiated xenon-hexane liquid solution at –78°C were measured and compared with those of pure hexane. Both dimers and hexene were formed in yields corresponding to essentially complete electron energy transfer at 0.04 mole fraction of hexane in xenon. The distribution of the dimers and hexene was similar for all mole fractions studied. It was concluded that the precursors of the products were substantially the same whether they arose from energy transfer or direct radiolysis. The electron transfer from hexane to ionized xenon was postulated as the predominant mechanism of energy transfer. It was also postulated that the product precursors were hexane ions. (F.J.H.)

**32218** RATE-DETERMINING STEP IN ANNEALING REACTIONS FOLLOWING NEUTRON CAPTURE IN CRYSTALLINE COBALT COMPLEXES. Yasukawa, Tamio; Saito, Nobufusa (Tokyo Univ.). J. Inorg. Nucl. Chem., 27: 1433-5(June 1965).

Experiments were carried out on $[M(NH_3)_6][M'(OX)_3] \cdot 3H_2O$, where OX denotes an oxalate ion and M and M' represent chromium or cobalt ions, to ascertain the rate-determining step in annealing reactions following neutron capture. Only small radioactivities were observed in the $[M(NH_3)_6]^{3+}$ fraction when these irradiated complexes were held in air at 78°C. However, when kept in an ammonia atmosphere at 78°C the major part of the recoil atoms assumed the chemical form $[M(NH_3)_6]^{3+}$. The results suggested that the rate-determining step in the process is the diffusion of ammonia molecules in the crystal. (M.C.G.)

**32219** RADIOLYTIC STUDIES OF ACTINOMETRIC REACTIONS BY GAMMA RAYS OF $Co^{60}$. Azim, M. A.; Fazal, Nasir Ahmad (Government Coll., Lahore). J. Nat. Sci. and Math., 4: 45-9(Oct. 1964).

An investigation was made on the effect of various foreign substances on the gamma-induced oxidation of oxalates by mercuric chloride. The influence of dose rates, of reactant concentration, and of temperature was also determined. (L.B.S.)

**32220** OXIDATION OF $Cu_2Cl_2$ BY GAMMA RAYS OF $Co^{60}$. Azim, M. A.; Fazal, Nasir Ahmad (Government Coll., Lahore). J. Nat. Sci. and Math., 4: 51-3(Oct. 1964).

Cuprous chloride oxidation was studied by the volumetric method by $^{60}Co$ gamma irradiation to high doses. It was observed that cuprous chloride oxidation was fairly large. The ability of its oxidation shows that this salt has a definite positive ERP (equivalent redox potential). The G value was found to be equal to 10. (L.B.S.)

**32221** THE RADIATION-INDUCED OXIDATION OF ORGANIC COMPOUNDS. Dobson, G.; Hughes, G. (Univ. of Liverpool). J. Phys. Chem., 69: 1814-19(June 1965).

The radioinduced oxidation of selected organic compounds was studied. Cyclohexane, in particular, was investigated in detail. Product yields were measured, and the effect of scavengers on these yields was studied. For all compounds studied, it was concluded that a significant fraction of the carbonyl yield was formed in a process, which was not interfered with by conventional radical scavengers. This was attributed to a molecular oxidation process. (auth)

**32222** THE RADIOLYSIS OF AQUEOUS NITRATE SOLUTIONS. Hyder, M. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Phys. Chem., 69: 1858-65(June 1965). (TID-21151)

The production of nitrite from neutral and alkaline solutions of sodium nitrate by $^{60}Co$ $\gamma$ radiation was measured over a range of nitrate concentrations from $10^{-3}$ to 4.0M. The production of $O_2$ from these solutions at pH 13 was also measured, and the origin of the $O_2$ was determined by labeling the water with $^{18}O$. The effect of scavengers, particularly $O_2$ and $I^-$, on the nitrate reduction was determined. From these studies, and from comparisons with ultraviolet photolysis and with previously published work, the radiolysis of $NO_3^-$ in neutral solutions was concluded to involve three effects: reduction of $NO_3^-$ by electrons and H atoms, direct excitation by radiation, and an effect possibly due to excited water molecules or spur reactions. In alkaline solutions an additional contribution is found, probably from the reaction of $O^-$. The data allowed a determination of $G_{e^-_{aq}} \cong 3.8$ and $G_{-H_2O} \cong 4.5$ at pH 13. (auth)

**32223** THE EFFECT OF GALVINOXYL ON THE RADIOLYSIS OF BENZENE–BUTENE-2 MIXTURES. Cundall, R. B.; Griffiths, P. A. (Univ. of Nottingham, Eng.). J. Phys. Chem., 69: 1866-7(June 1965).

By the use of galvinoxyl it was found that the scavengable radical yield ($G_R$) in $\gamma$-irradiated benzene was 0.74, but no reaction with excited states was detectable. The effect on the geometrical isomerization of cis-butene-2 showed that the stable free radical was able to quench the excited triplet state of benzene with high efficiency. An estimate of about 4 for the triplet G value in irradiated benzene was quoted. The lifetime of this state is short, about $10^{-8}$ sec, under the conditions of the experiments. (auth)

**32224** MEASUREMENT BY BENZOATE RADIOLYTIC DECARBOXYLATION OF RELATIVE RATE CONSTANTS FOR HYDROXYL RADICAL REACTIONS. Matthews, R. W.; Sangster, D. F. (Australian Atomic Energy Commission Research Establishment, Sydney). J. Phys. Chem., 69: 1938-46(June 1965).

The decarboxylation of $^{14}C$-carboxyl-labeled benzoate during the irradiation of dilute, aerated aqueous solutions by ionizing radiation was studied. It was found that, in addition to the $^{14}CO_2$ produced during the irradiation, there was a post-irradiation production of further carbon dioxide during the following few hours. From the kinetic salt effect and competitor studies, it was concluded that the hydroxyl radical is involved in the production of all the carbon dioxide found. Provided comparisons were made at a set time, the system could be used to measure over-all reaction rates for solute-hydroxyl radical reactions relative to the benzoate-$OH^-$ reaction rate. Values for 20 solutes were given and compared with some of the published values. The highest values found were 2.1 for ferrocyanide-$OH^-$ and 2.4 for iodide-$OH^-$. Values found for the aromatic compounds studied were between 0.39 for nitrobenzene and 1.6 for phenate. Where hydrogen abstraction was involved, lower values were found. (auth)

**32225** THE RADIATION-INDUCED OXIDATION OF p-XYLENE SENSITIZED BY ORGANIC BROMINE COMPOUNDS. Verdin, D.; Hyde, S. M.; Neighbour, F. (United Kingdom Atomic Energy Authority, Wantage, Berks, Eng.). J. Phys. Chem., 69: 1992-2000(June 1965).

The oxidation of p-xylene at 25°C induced by $^{60}Co$ $\gamma$ radiation was accelerated by the addition of organic bromine compounds. $CBr_4$ was the most efficient sensitizer, and the rate of absorption of oxygen accelerated to a maximum at about 2% oxidation and then decreased. The observed kinetics were consistent with a mechanism in which the autoretardation and the postirradiation oxidation result from the reaction, ROOH + HBr → RO + $H_2O$ + Br, between the hydroperoxide and hydrogen bromide formed as intermediates. (auth)

**32226** RADIOLYSIS OF BENZENE AND BENZENE-CYCLOHEXANE MIXTURES IN THE PRESENCE OF NICKEL TETRACARBONYL. Barzynski, Helmut F.; Hentz, Robert R.; Burton, Milton (Univ. of Notre Dame, Ind.). J. Phys. Chem., 69: 2034-7(June 1965).

G values of hydrogen and biphenyl formation in $\gamma$ irradiated mixtures of benzene and nickel tetracarbonyl showed that some excited benzene species are protected against decomposition by nickel tetracarbonyl. It is argued that two kinds of primary process contribute to the hydrogen yield: a rapid unimolecular elimination of molecular hydrogen that is not quenched by carbonyl and a process giving a second-order hydrogen yield that is associated with biphenyl formation and is quenched by carbonyl. Yields were determined for the major radiolysis products from benzene–cyclohexane mixtures containing nickel tetracarbonyl at fixed electron fraction ($\epsilon$ 0.68) at different electron fractions of each hydrocarbon in the range $\epsilon$ 0 to 0.32. At $\epsilon$ (nickel tetracarbonyl) 0.68 most of the cyclohexane decomposition was inhibited; the residual decomposition of the cyclohexane was to a major extent by rearrangement to ultimate molecules and to a minor extent by rupture into free radicals and atoms. These residual decomposition processes were not appreciably quenched by further addition of either protective agent. The suppression of products by benzene, in this case, represented actual scavenging of free radicals and atoms. (auth)

**32227** RADIATION CHEMISTRY OF PERFLUOROCYCLOHEXANE AND PERFLUOROCYCLOBUTANE. MASS

SPECTROSCOPIC IDENTIFICATION OF PRODUCTS. Fallgatter, Michael B.; Hanrahan, Robert J. (Univ. of Florida, Gainesville). J. Phys. Chem., 69: 2059-65(June 1965).

Dimeric hydrocarbons appeared to be the predominant products of the γ radiolysis of pure perfluorocyclohexane at low doses. They were separated and measured by gas chromatography and identified by mass spectrometry. Yields were dose dependent; initial G values were 2.2, 0.66, and 0.22 for perfluorobicyclohexyl, perfluorocyclohexylhexene, and perfluorocyclohexylhexane, respectively. Minor yields of low-boiling products were observed, as well as compounds in the C to $C_{11}$ range at higher doses. No perfluorocyclohexene was found. Perfluorocyclobutane was investigated qualitatively and gave considerable yields of $C_5$, $C_6$, and $C_8$ (dimer) compounds, as well as perfluoroethylene and perfluorocyclopropane. These results were compared with earlier work on fluorocarbons and other related systems. The mass spectra of several of the radiolysis products are reported. (auth)

**32228** RADIOLYTIC STRESS RELAXATION OF AN ETHYLENE-PROPYLENE COPOLYMER. Yu, Hyuk; Wall, Leo A. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 69: 2072-8(June 1965).

The kinetics of network chain scission induced by γ rays was studied by stress relaxation at constant elongation under vacuum and in air. The rate of chain scission of a 1:1 ethylene–propylene copolymer was found to be independent of initial network chain density, and the initial rates were roughly the same in air and under vacuum. Parameters for crosslinking induced by γ rays were obtained by sol extraction and by measurement of elastic properties of the resulting networks. G values for scission and crosslinking and gel dose, obtained by stress relaxation, by elastic properties, and by sol extraction, were found to be in agreement with each other. (auth)

**32229** THERMOLUMINESCENCE OF IRRADIATED POLYETHYLENE. Nakai, Yohta; Matsuda, Koji (Japanese Assn. for Radiation Research on Polymers, Osaka). Japan. J. Appl. Phys., 4: 264-8(Apr. 1965).

Thermoluminescence glow curves of irradiated polyethylene were obtained under several conditions to provide information to clarify the luminescent mechanism. A glow curve for polyethylene shows peaks at −175, −120 and −40°C. The −40°C peak is unstable and varies between −30°C to −50°C, depending on factors such as the dose and type of polyethylene. A great decrease in the luminescent intensity following exposure to ultra-violet, infrared, or day light was observed. The intensity of the glow curves decreases even though the samples are kept in the dark after irradiation at −196°C. (auth)

**32230** NOTE ON THE REACTION BEHAVIOR OF OH RADICALS RADIOLYTICALLY PRODUCED IN NEUTRAL OR ACID SOLUTIONS. Sarrach, D. (Institut fuer Angewandte Isotopenforschung, Deutsche Akademie der Wissenschaften, Berlin). Kernenergie, 8: 220-3(Apr. 1965). (In German)

Aqueous $2 \times 10^{-3}$ M neutral or 0.8 N acid ethanol solutions saturated with air and with addition of potassium bromide were irradiated with $^{60}$Co gamma radiation, and the hydrogen peroxide and acetaldehyde yields were determined. Using these yields as a function of the quotient of bromide and alcohol concentration, the ratio of the rate constants $k_4/k_2$ of the reactions of the oxidizing radicals with bromide and ethanol, respectively, amounts to 0.63 for neutral and to 3.3 for acid solutions. As an anionic effect is out of question, the oxidizing radical is supposed to exist in another state of solution in acid and in neutral solution. (auth)

**32231** RADIOTHERMOLUMINESCENCE OF VARIOUS ZnS PHOSPHORS. Oishi, Masahiro; Huzimura, Ryoitiro (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 14: 134-41(Apr. 1965). (In Japanese)

The thermoluminescence of various ZnS type phosphors after excitation by uv light, 4.5-Mev electrons, or γ rays of $^{60}$Co was studied for two emission bands, blue and green. Three main groups of glow peaks were usually observed. The ratio of the shallow peak height to the middle one of green glow depended little, if at all, on the excitation dose for each type of excitation. The fillings of the shallow traps of blue glow were incomplete after excitation by γ rays or electrons. The ratio of blue glow intensities to the green glow after excitation by γ rays or electrons was smaller than that obtained after uv excitation. As to the effects of impurities and the firing conditions, it was confirmed that the peak of the deepest trap arose as an effect of oxygen and the peak of the middle trap appeared as an effect of Cl coactivator. (auth)

**32232** GAMMA-RAY-INDUCED POLYMERIZATION OF SOME VINYLTIN COMPOUNDS. Hayakawa, Kiyoshi; Kawase, Kaoru; Matsuda, Tatsuo (Government Industrial Research Inst., Nagoya, Japan). Nature, 206: 1038-9 (June 5, 1965).

Triethylvinyl tin and triphenylvinyl-tin were irradiated using gamma rays from $^{60}$Co and the formation of polymeric substances observed. Conversion of the monomer increased almost linearly with irradiation time. Infrared spectra of the polymer were obtained. G-values were calculated. (M.C.G.)

**32233** LOW ATOMIC NUMBER DYE SYSTEMS FOR IONIZING RADIATION MEASUREMENT. McLaughlin, William L.; Chalkley, Lyman (National Bureau of Standards, Washington, D. C.). Photo. Sci. Eng., 9: 159-66 (May-June 1965).

In radiotherapy, radiation processing, and intense-beam dosimetry, the problems of isodose measurement and depth-dose distribution studies on a microscopic scale were not solved satisfactorily by conventional radiation measurement systems. With silver-halide photographic emulsions, for example, large differences in sensitivity to electron and photon energies in the 10 to 300 kev region make the evaluation of heterogeneous radiation fields difficult. Even with very fine-grain emulsions granularity causes problems in high-power microscopic studies. Organic dye systems, although considerably less sensitive than most silver-halide emulsions, led to much smaller errors in the interpretation of their response to intense ionizing radiation beams, due to lower spectral sensitivity variation. Colorless derivatives of triphenyl methane dyes, such as stabilized forms of pararosaniline nitriles, showed special potential for dosimetry, because of the high intensity of color formed on irradiation, the stability of color after irradiation, the absence of response to wavelengths longer than 330 mμ, the absence of reciprocity failure, and the capability of being incorporated easily into a number of media. (auth)

**32234** INFLUENCE OF RADIATION TEMPERATURE ON THE STABILITY OF F CENTERS AND INTERSTITIALS. Sibley, W. A.; Sonder, E. (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 14: 900-2(May 31, 1965).

Use is made of flow-stress and optical-absorption measurements to examine the stability of interstitials and F centers, respectively. The results show that interstitials are produced together with F centers at all temperatures and, that the stability of the defects remaining at 300°K depends on the radiation temperature. (M.O.W.)

**32235** THE RADIATION CHEMISTRY OF LOW TEMPERATURE METHANOLIC GLASSES. Dainton, F. S.; Salmon, G. A.; Teply, J. (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A, 286: 27-44(Mar. 25, 1965).

A study was made of the visible, uv and ESR spectra produced when glassy methanol at 77°K is irradiated with cobalt-60 γ-rays and of the effects on these of: various additives including 2-methyl-1-pentene, sodium hydroxide, sulfuric acid, carbon tetrachloride, benzyl chloride, ferric chloride and naphthalene; subsequent illumination with either uv light or visible light (546 and 578 nm); and subsequent warming. The data are consis-

tent with a mechanism the major features of which are $CH_3OH_{gl} - \gamma \rightarrow e_t^- + CH_3OH(- CH_3\dot{O}H_2 + .CH_2OH)$ where $e_t^-$ is an electron trapped in the glassy matrix. $e_t^-$ can migrate perceptibly but slowly through the glass at temperatures ≥100°K and can be photo-detached from the matrix by red or uv light, in both cases ultimately reacting with $CH_3\dot{O}H_2$. The radical $\cdot CH_2OH$ becomes mobile at temperatures not less than 106°K and reacts bimolecularly to form glycol or formaldehyde. It is decomposed by uv light, but reaches a stationary concentration owing to the reaction sequence $\cdot CH_2OH + h\nu_1 \rightarrow H_2 + \dot{C}HO$; $\dot{C}HO + h\nu_2 \rightarrow CO + H^*$; $H^* + CH_3OH \rightarrow H_2 + \cdot CH_2OH$. Solutes may compete with the electron trapping process and also react with electrons rendered mobile by the action of heat or light on trapped electrons. (auth)

**32236** FORMATION OF CYSTEAMINE FROM CYSTAMINE IRRADIATED WITH X RAYS IN THE PRESENCE OF REACTANTS FOR THE THIOL GROUP. Misiti, Paola; Boccacci, Dorello, M.; Quintiliani, M. (Istituto Superiore di Sanita, Rome). Rend. Ist. Super. Sanita, 27: 126-32 (1964). (In Italian)

The formation of cysteamine from $^{35}S$-labeled cystamine irradiated with x rays in the presence of N-ethyl maleimide or iodoacetic acid, which block the reoxidation of the newly formed cysteamine to cystamine, has been studied. Solutions $2 \times 10^{-3}$M in cysteamine were treated with 160 krad of 200 kv rays in Lusteroid tubes immersed in ice water. In the absence of the reactant, taurine and hypotaurine were found as products by electrophoresis. Cysteamine was found in addition when N-ethyl maleimide or iodoacetic acid was added. The percent of total activity found in cysteamine derivatives as a function of the concentration of the two reagents and the nature of the atmosphere was found as follows: N-ethyl maleimide concentration × $10^3$, $N_2$ atmosphere, $O_2$ atmosphere: 1, 18.0, 8.9; 2, 18.1, 9.2; 4, 12.3, 7.7; 8, 7.3, 6.9. Iodoacetic acid concentration M × $10^3$, $N_2$, $O_2$: 1, 5.4, 2.0; 2, 8.8, 2.8; 4, 13.4, 2.3; 8, 13.7, 1.8. The value of percent activity in derivatives of cysteamine ($2 \times 10^{-3}$M) with N-ethyl maleimide ($2 \times 10^{-3}$M) or iodoacetic acid ($8 \times 10^{-3}$M) is plotted as a function of x-ray dose. Both reagents have a nearly identical effect, and to 210 kR (22%) the effect is linear. At 430 kR, about 30% derivative activity is found. The percent of activity found in taurine and hypotaurine is independent of the presence of additives to the thiol bond, and equals ca. 2.2% in $N_2$ and 5.5% in $O_2$. Mechanisms are discussed. (BBB)

**32237** EFFECTS OF RADIATION WITH VARIOUS LINEAR ENERGY TRANSFER ON DYE-CONTAINING POLYMER FILMS. Lavrentovich, Ya. I.; Levon, A. I.; Kabakchi, A. M. (Pisarzhevskii Inst. of Physical Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 440-9(1965). (In Russian)

Studies were made of the effects of various types of radiation on polyvinyl alcohol containing methylene blue and methyl orange. Radiochemical yields for $^{60}Co$ γ irradiation and for $^{10}B(n,\alpha)^7Li$ reaction products were determined. It was found that variation in the linear energy transfer by a factor of three had no influence on yields. An analysis was made of the mechanism of radiolytic dye reduction. (R.V.J.)

**32238** INHIBITING EFFECTS OF CERTAIN SOLID IMPURITIES ON RADIATIVE-CHEMICAL PROCESS. Lukhovitskii, V. I.; Tsingister, V. A.; Laguchcva, R. M.; Karpov, V. L. Zh. Fiz. Khim., 39: 984-6(Apr. 1965). (In Russian)

Heterogeneous inhibition of homogeneous radiation chemistry processes was detected in the presence of solid impurities, containing metals of variable valence in the lower valence states ($Fe^{2+}$). Explanation of this effect on the basis of modern concepts of the mechanism of radiation chemistry processes did not seem possible. (tr-auth)

**32239** ABSORPTION OF MICROQUANTITIES OF $HPO_4^{2-}$ IONS BY RADIOACTIVE AND IRRADIATED $BaSO_4$ PRECIPITANTS. Gromov, V. V.; Kepak, F.; Spitsyn, Vikt. I. p.110-13 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

Investigations of the absorption of microquantities of $HPO_4^{2-}$ from aqueous solutions of $^{35}S$-labeled of $BaSO_4$ different specific activities as well as from solutions of non-active samples of $BaSO_4$, irradiated with high-energy electrons, indicated that in the cases given the microcomponents penetrate into the crystalline lattice of the $BaSO_4$. It was established that with increases in the dose of the absorbed β emission the extent of the sorption of the microimpurities decreases in the commercial preparations of $BaSO_4$. (tr-auth)

**32240** RECOIL LABELING OF ORGANIC MOLECULES WITH SPECIAL REFERENCE TO COMPOUNDS OF BIOLOGICAL AND BIOCHEMICAL SIGNIFICANCE. Wolf, A. P. (Brookhaven National Lab., Upton, N. Y.). p.423-35 of "EUR-2200.e."

The various non-synthetic methods used in the labeling of organic compounds with radioactive tracers are reviewed. Emphasis is placed on applications of nuclear recoil methods in the preparation of compounds for use in biological and medical studies. The preparation of $^{14}C$-labeled isonicotinic acid hydrazide is cited as an example. Examples are also described of compounds labeled with tritium and $^{35}S$ by the recoil method. (C.H.)

**32241** NEW ASPECTS OF RECOIL LABELING (REVIEW AND PROSPECTS). Stoecklin, G. (Institut fur Radiochemie, Kernforschungsanlage, Julich, West Germany). p.437-57 of "EUR-2200.e."

The preparation and biomedical uses of organic compounds labeled with relatively short-lived radioisotopes are discussed. Nuclear recoil reactions are described for the production of $^{11}C$, $^{13}N$, $^{18}F$, $^{31}Si$, $^{32}P$, $^{38}Cl$, $^{76}As$, $^{82}Br$, $^{126}I$, $^{126}I$, and $^{131}I$. (C.H.)

**32242** PHENYL POLYSILOXANES. (to General Electric Co.). British Patent 980,102. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

A method is described for the preparation and polymerization of phenylpolysiloxanes. The polymeric material consists essentially of the recurring unit having the formula:

$$(C_6H_5)_2Si-O\left[\begin{matrix}C_6H_5\\|\\Si-O\\|\\C_6H_5\end{matrix}\right]_a(C_6H_5)_2Si-O-(R)_2Si-(C_6H_4)-Si(R)_2O.$$

The silicone rubbers produced by the crosslinking of the polymers are particularly useful in applications where resistance to irradiation is required, where flexibility at elevated temperatures is required, and where an exceptionally high degree of thermal stability is required. (B.L.M.)

**32243** PROCESS FOR PRODUCING POLYOXYMETHYLENE OF GOOD THERMAL STABILITY. (to Toyo Rayon Kabushiki Kaisha). British Patent 979,263. Jan. 1, 1965. Priority date Aug. 9, 1961, Japan.

A process is described for the production of polyoxymethylene of good thermal stability by irradiation of a high-viscosity polyoxymethylene (viscosity number of at least 3). The irradiation is carried out in a non-oxidizing medium such as methanol or toluene at a vacuum using $^{60}Co$ γ radiation. The irradiation is carried out at a temperature between −250 to 200°C at a dosage of 0.05 to 50 Mrad. After irradiation, the polyoxymethylene is subjected to a heat treatment at 0 to 350°C for at least 30 min in a vacuum to decompose and remove the unstable portions. (B.L.M.)

**32244** CYCLOPOLYSILOXANES. (to General Electric Co.). British Patent 980,103. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

A method is described for the preparation and polymerization of cyclopolysiloxanes in which all the organo groups are phenyl groups. The polymerized materials consist essentially of recurring units having the formula: $-(C_6H_5)_2Si[O-(C_6H_5)_2Si]_nO-(C_6H_5)_2Si-O-(C_6H_5)[(C_6H_5)_2SiO]Si-O-$. The polymers can readily be molded into desired

shapes to form articles that are resistant to changes caused by ionizing radiation. Crosslinking of the polymers can be affected to produce silicone rubbers. (B.L.M.)

**32245** TRIFLUOROMETHYLPHENYL POLYSILOXANES. (to General Electric Co.). British Patent 980,109. Jan. 13, 1965. Priority date Dec. 18, 1961, United States.

The method previously described was applied to the preparation and polymerization of trifluorophenylpolysiloxanes. These siloxanes can be polymerized with each other to form homopolymers or with other cyclic polydiorganosiloxanes to form copolymers. The silicone rubbers formed from these polymers are more resistant to the swelling effect of aliphatic hydrocarbon solvents than conventional silicone rubbers and also show improved resistance to irradiation. The silicone rubbers are particularly useful as flexible supports for elements to be used in reactors. (B.L.M.)

**32246** SYNTHESIS OF AMINO ACIDS BY HIGH INTENSITY IONIZING RADIATION. Hasselstrom, Torsten; Henry, Malcolm C. U. S. Patent 3,162,591. Dec. 22, 1964. Filed Oct. 10, 1957.

A process is reported for converting ammonium acetate in aqueous solutions to amino acids, particularly glycine, aspartic acid, and diaminosuccinic acid. The aqueous solutions are subjected to high-intensity radiation equivalent to at least $10^6$ ev until a dosage of at least $10^7$ rep is absorbed and at least a substantial part of the ammonium acetate is converted to amino acids. The high-intensity radiation may be electrons, gamma rays, or beta rays. The resulting mixture of amino acids is separated from the unreacted ammonium acetate solution, and the unreacted solution mixed with fresh ammonium acetate solution is recirculated to the radiation source. (B.L.M.)

**32247** IRRADIATION CONVERSION OF PARAFFINS. Wilson, Alexander T.; McCaulay, David A. (to Standard Oil Co.). U. S. Patent 3,177,132. Apr. 6, 1965. Filed Dec. 30, 1958.

In a non-catalytic process for conversion of light paraffins to liquid products boiling above butane, a feedstock is subjected to a total dosage of about $10^6$–$10^{10}$ rep of beta and/or gamma radiation. The feedstock consists of substantially olefin-free butane, isobutane, and propane. After or during irradiation liquid products are separated from the reaction mixture, and unconverted material may be recycled. (A.G.W.)

**32248** STABILIZATION OF ORGANIC FLUIDS AGAINST RADIATION DECOMPOSITION AND SYSTEMS EMPLOYING SAME. Gutzke, Mark E.; Yanko, William H. (to Monsanto Co.). U. S. Patent 3,183,165. May 11, 1965. Filed Oct. 10, 1960.

A mixture of polyphenyl hydrocarbons (50 wt %) and hydrogenated polycyclic hydrocarbons having a boiling point of not more than 600°C is proposed as a reactor moderator and/or coolant. The polycyclic hydrocarbons are present in the mixture in an amount sufficient to reduce radiolytic damage as compared to polyphenyls alone. The mixture has not more than 30% of the theoretical number of hydrogen atoms for complete saturation of the mixture, preferably 5–25%. The radiation resistant polycyclic hydrocarbons can be made by adding hydrogenated polycyclic hydrocarbons to polyphenyls and/or fused-ring aromatic hydrocarbons or alternatively by partially hydrogenating polyphenyls and/or fused-ring aromatic hydrocarbons thus building a stability into the basic aromatic moderator/coolant. (B.L.M.)

## Radiochemistry

**See also Separation Processes and Procedures.**

*Refer also to abstracts 31771, 32545, and 32546.*

**32249** (NAS-NS-3008(Rev.)) THE RADIOCHEMISTRY OF RHODIUM. Choppin, Gregory R. (Florida State Univ., Tallahassee); Armstrong, James C. Jr. (Hazelton-Nuclear Science Corp., Palo Alto, Calif.). May 1965. Contracts AT(40-1)-1797 and AT(04-3)-157. 86p. Dep.(mn); $1.00(cy), 2(mn) CFSTI.

"Nuclear Science Series" of the National Research Council. Committee of Nuclear Science.

This monograph is a comprehensive compilation of radiochemical and nuclear chemical information on rhodium. Sample dissolution methods, separation reactions, counting techniques, and radiochemical separation procedures are discussed in detail. (D.L.C.)

**32250** (UCRL-11833(p.112-20)) AN IMPROVED LIQUID SCINTILLATION COUNTING METHOD FOR $Fe^{55}$ AND $Fe^{59}$ IN BLOOD. Saito, Hiroshi (Lawrence Radiation Lab., Univ. of California, Berkeley).

Fast processing and high counting efficiency combined with accuracy and stability are features of a liquid scintillation method for counting $^{55}Fe$ and $^{59}Fe$ in blood samples. Iron in dry ash is purified centrifugally using hydrochloric acid and sodium hydroxide. Phosphoric acid is used for decolorizing. (H.G.D.)

**32251** IODINE 132 IN NUCLEAR MEDICINE. I. PREPARATION AND DETERMINATION OF ACTIVITY OF IODINE 132. Jirounek, P.; Raban, P.; Brousil, J. (Charles Univ., Prague). Cesk. Radiol., 18: 318-26(1964).

Methods are described for preparing iodine-132 directly at the medical center, a necessary step in view of its short half-life. Conditions were studied for obtaining optimal total and specific activity of iodine-132 prepared by the chromatographic methods from a generator supplied by Amersham Laboratories, England. Curves were plotted for the approximate assessment of activity of the iodine-132 obtained, an ionization chamber constructed, and a dosimetric method for iodine-132 elaborated. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**32252** FACTORS INFLUENCING THE LOSS OF CARBON-14 FROM LABELLED CARBONATES. Evans, H. D.; Mubarak, M. A. (Imperial Coll. of Science and Tech., London). Intern. J. Appl. Radiation Isotopes, 16: 387-9(June 1965).

Factors that may affect $^{14}C$ activity of labeled carbonates are reviewed. It was concluded that loss of activity may be due to exchange with inactive $CO_2$ dissolved in solutions from which the source is evaporated or exchange with atmospheric $CO_2$ in contact with the dried source. Losses as high as 95% in 24 hr were observed from these causes. (C.H.)

**32253** NUCLEAR CHEMISTRY RESEARCH AND RADIOISOTOPES IN THE HUNGARIAN CHEMICAL INDUSTRY. Foeldiak, G. Magy. Kem. Lapja, 19: 397-9(Aug. 1964). (In Hungarian)

Research in the field of nucleonics, production of radioisotopes, and the industrial application of the latter in Hungary are discussed. Fissionable isotopes are put on the market in the form of elements and their inorganic or organic compounds. A considerable number of university departments and research institutes are engaged in experiments with these or on tracer techniques, e.g., in the elucidation of reaction kinetics or adsorption phenomena. Several chemical processes and apparatus installed in commercial plants are being studied with the help of tracer techniques, e.g., to establish optimum capacities or the optimum time of a mixing operation. A start was made with the application in the chemical industry of radioisotopes for the indication of the level of a liquid in a closed vessel, the measurement of thickness, and density measurements. (OID)

**32254** BIOSYNTHESIS OF 4-$^{14}C$- AND 7$\alpha$-$^{3}H$-LABELED 20$\alpha$-HYDROXYPREGN-4-EN-3-ONE AND 7$\alpha$-$^{3}H$-3$\beta$, 20$\alpha$-DIHYDROXYPREGN-5-ENE. Purdy, Robert H.; Halla, Maerta; Little, Brian (Boston City Hospital). Steroids, 4: 625-33(Nov. 1964).

Radioactive 20$\alpha$-dihydro derivatives of progesterone and pregnenolone were desired for use in isotopic tracer studies. Lithium aluminum hydride reduction of the $C_{20}$ ketone

group yields both the 20$\alpha$ and 20$\beta$ epimers in a ratio of 1 to 2. The biosynthetic preparation of three radioactive 20$\alpha$-dihydro compounds is described, using the soluble 20$\alpha$-hydroxysteroid dehydrogenase from human placenta, which is notably similar in physical properties to the placental 17$\beta$-hydroxysteroid dehydrogenase. The radioactive 20$\alpha$-hydroxysteroids free of any 20$\beta$-epimers were recovered in greater than 40% yield after partition column chromatography. The reactions using $^{14}C$- and $^{3}H$-labeled progesterone yielded 24% of the original radioactivity in the progesterone region and 40% or more in the peak tubes of a product with the mobility of 20$\alpha$-hydroxypregn-4-en-3-one. Aliquots of these labeled products were diluted with unlabeled 20$\alpha$-hydroxypregn-4-en-3-one and subjected to 120-transfer countercurrent distributions for analysis of their radiochemical purity. A single peak of radioactivity was found in each case. The countercurrent distribution of 7$\alpha$-$^{3}H$-3$\beta$, 20$\alpha$-dihydroxypregn-5-ene indicated that radiochemical purity was achieved. This was supported by oxidation to 7$\alpha$-$^{3}H$-20$\alpha$-hydroxypregn-4-en-3-one using the placental 3$\beta$-hydroxysteroid dehydrogenase. (BBB)

**32255** UNIVERSAL TABLE FOR CORRECTING FOR RADIOACTIVE DECAY. Marais, P. G. (Fruit and Technology Research Inst., Stellenbosch, S. Africa). Tech. Commun., Dept. Agr. Tech. Serv., Pretoria, S. Africa, No. 36, 10p.(1965).

A table is given which makes it possible to correct for radioactive decay of any radioisotope. A decay correction table is the most rapid and accurate method to correct for radioactive decay. However, it is inadvisable to calculate tables for individual isotopes. This problem can be solved effectively by expressing the decay period as a fraction of the half life, so that a single table can be used for all isotopes. The first factor considered in calculating such a table is the smallest time interval ($\Delta T$) for which correction for radioactive decay is required, since this limits its accuracy. Although an accuracy of one per cent would satisfy most requirements, decay correction is only one of several corrections to be applied to radiometric measurements and the best approach is to avoid the introduction of unnecessary errors. It was therefore decided to choose a convenient time interval given by: $\Delta T = T/500 \log_e 2$ which gives the decay correction factor for this fraction on the half life as: $K = {}_e0.002 = 1.002$. In calculating correction factors for any decay period (t) the number of time intervals ($\Delta T$) over which it extends must be determined. This quantity $\Delta H$ is given by: $\Delta H = t/\Delta T$, so that $\Delta H = 1$ when $t = \Delta T$. The correction factor of 1.002 which applies to the time interval $\Delta T$ is therefore the value when $\Delta H = 1$. The general factor for any $\Delta H$ is given by $e^{0.002\Delta H}$ so that the value for $\Delta H = 2$, for example, is $e^{0.004}$. By calculating the value for $\Delta H = 1$ accurate to 10 figures, practically all multiples of $\Delta H$ can be determined by multiplication. Only a few check points are required and their calculations are extremely simple due to the time interval chosen. The correction factors corresponding to different $\Delta H$ values are given in a table. The half life (T) of a particular isotope can be rapidly calculated if the decay factor is known. The $\Delta H$ value corresponding to this factor is obtained from the table and T is calculated from: $T = 346.6\ t/\Delta H$. The value of $\Delta H$ is obtained by multiplying the decay period (t) by the conversion factor (C). This value is different for each isotope and depends on its half life. However, C values can easily be calculated for groups of isotopes. Those for most isotopes used in agricultural research are listed in another table. Some examples of use of the tables are given. The advantages of the universal table are discussed. The main advantages of this method to correct for radioactive decay are discussed. (BBB)

**32256** THE INFLUENCE OF GERMANIUM RADIOACTIVITY ON ITS EVAPORATION. Tseplyaeva, A. V.; Priselkov, Yu. A. Vestn. Mosk. Univ., Ser. II, Khim., No. 2, 54-5(Mar.-Apr. 1965). (In Russian)

Experiments with liquid Ge vapor pressure showed that specimens containing radioactive $^{71}Ge$ have a 20 to 25% higher rate of evaporation than ordinary specimens. (R.V.J.)

**32257** ADVANCES IN TRACER METHODOLOGY. VOLUME 2. A Collection of Papers Presented at the Sixth, Seventh, and Eighth Symposia on Tracer Methodology Plus Other Papers Selected by the Editor. Rothchild, Seymour, ed. New York, Plenum Press, 1965. 325p. $12.50.

Papers presented at the Sixth, Seventh, and Eighth Symposia on Tracer Methodology and other selected papers are presented. Topics covered include: methods for labeling compounds, special analytical techniques, biochemical applications, clinical applications, and health physics. Separate abstracts were prepared for eight papers. Abstracts of fourteen papers were previously prepared for NSA. They appeared as abstract Nos. 17: 30258, 31805, and 35638; 18: 6733, 9978, 10175, 13802, 17420, 17873, 27040, 27041, 31096, and 43391; and 19: 22803. (M.C.G.)

*For abstracts of individual papers see: 31690, 31691, 31692, 31693, 31748, 32094, 32095, and 32258.*

**32258** $C^{14}$-LABELING USING CARBENE INSERTION–APPLICATION TO SATURATED HYDROCARBONS. Muha, M. A.; Bastin, E. L.; Gordon, B. E. (Shell Development Co., Emeryville, Calif.). p.39-48 of Advances in Tracer Methodology. Vol. 2. New York, Plenum Press, 1965.

The methylene insertion reaction was used to prepare $^{14}C$-labeled saturated hydrocarbons from a single starting material. About one half of the activity in the $^{14}C$ source (N-methyl-$^{14}C$-N-nitroso-p-toluenesulfonamide) can be incorporated in the final products. The time required for a synthetic run is about 3 days. By use of preparative-scale gas chromatography, products of extremely high chemical purity (>99.9%) can be isolated. This technique also insures that radiochemical purity will be high. (M.C.G.)

**32259** DEVIATIONS FROM THE HENRY LAW IN RADIOCHEMICAL SORPTION SYSTEMS. Egorov, Yu. V. p.113-17 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The classification of the deviations from Henry's law in radiochemical sorption systems was investigated. (tr-auth)

**32260** PREPARATION AND BIO-MEDICAL APPLICATION OF LABELED MOLECULES. Proceedings of a Symposium, Venice, August 23-29, 1964. Sirchis, J., ed. (European Atomic Energy Community). Dec. 1964. 514p. (EUR-2200.e; CONF-774)

Separate abstracts were prepared for 45 papers presented at this symposium. One paper was abstracted previously and appeared in NSA Vol. 19 as number 1952. (C.H.)

*For abstracts of individual papers see: 32261, 32262, 32263, 32264, 32265, 32266, 32267, 32268, 32269, 32270, 32271, 32272, 32273, 32274, 32275, and 32593.*

**32261** THE PREPARATION OF INDAN-2-$^{14}C$. Volponi, L.; Colombini, C. (Università, Padua). p.9-12 of "EUR-2200.e."

Phthalid was fused in an open tube with anhydrous $NaCN-{}^{14}C$, and the fusion product was hydrolyzed with dilute $H_2SO_4$, obtaining homophthalic acid labeled in the carboxylic group of the acetic acid chain. The silver salt, refluxed with MeI, gave the corresponding ester that was then reduced to homophthalyl alcohol by $LiAlH_4$. Treatment of the product with $PBr_3$ yielded 1-Br-methyl-2(-$\beta$-Br-ethyl)benzene from which indan-2-$^{14}C$ was obtained by ring closure using Zn powder in n-heptane. The procedure does not appear practical for large runs. (D.E.B.)

**32262** SIMULTANEOUS PREPARATIONS OF DL-TRICARBALL[YL]IC ACID-1-$^{14}C$ AND $\gamma$-AMINOBUTYRIC ACID-1-$^{14}C$. Colombini, C.; Rizzardi, G.; Sindellari, L. (Università, Padua). p.13-15 of "EUR-2200.e."

HBr was added to diallyl itaconate in the presence of catalytic amounts of benzoyl peroxide, giving di-(3-bromo-

propyl) bromomethyl succinate. The corresponding trinitrile was obtained using NaCN. A mixture of tricarballylic and γ-hydroxybutyric acids was obtained by dilute basic hydrolysis of the nitrile. The two acids were separated by using their different solubilities in ethyl ether. The hydroxybutyric acid was then converted to aminobutyric. (D.E.B.)

**32263** SYNTHESIS OF HIGH SPECIFIC ACTIVITY l-PHENYLALANINE-2,3-$^{3}$H. Winand, M. (CEN/SCK, Mol, Belg.), Bricteux-Gregoire, S.; Verly, W. G. p.17-22 of "EUR-2200.e."

The synthesis involves the preparation and tritium reduction of α-acetamino-cinnamoyl-l-glutamic acid, resulting in diastereoisomers of acetyl-phenylalanyl-l-glutamic acid. The product is separated, hydrolyzed, and passed through an ion-exchange column for l-phenylalanine collection. (D.E.B.)

**32264** PREPARATION OF TRITIATED ACTINOMYCIN AND PURIFICATION BY A SPECIFIC METHOD. Cardinaud, R.; Grosse, N.; Fromageot, P. (Commissariat a l'Energie Atomique, Saclay, France). p.23-9 of "EUR-2200.e."

Labeling is accomplished by contacting actinomycin and tritium at uniform pressure under a high-frequency discharge for twenty min. Purification consists of four dissolution-extraction-evaporation steps. (D.E.B.)

**32265** PREPARATION OF 1-$^{14}$C-2-METHYL-CIS-OCTENOATE AND 1-$^{14}$C-CIS-2-OCTENOIC ACID. Buehler, M. F.; Mitta, A. E. A.; Lezerovich, J. B. (Comision Nacional de Energia Atomica, Buenos Aires). p.31-3 of "EUR-2200-e."

2-methyl-1-$^{14}$C-cis-octenoate was synthesized by 1-heptynyl magnesium bromide carbonation with $^{14}$C-labeled carbon dioxide, esterification with methanol of the 1-$^{14}$C-2-octenoic acid obtained, and partial hydrogenation of the ester in the presence of Lindlar's catalyst. (D.E.B.)

**32266** SYNTHESIS OF ISOTOPICALLY PURE ETHANE-1,2-$^{3}$H. Aliprandi, B.; Cacace, F.; Guarino, A. (Universita, Rome). p.35-8 of "EUR-2200.e."

The yield of the reaction $C_2H_4 + T_2 \rightarrow C_2H_4T_2$ in 60 hr at -7°C was around 30%. The product contained a number of impurities that were effectively removed by gas chromatographic purification. (D.E.B.)

**32267** THE RADIOCHEMICAL SYNTHESIS OF SPECIFICALLY LABELED NICOTINE MOLECULES. Decker, K. (Universitat, Freiburg i. B.). p.39-44 of "EUR-2200.e."

Nicotine was labeled with $^{14}$C in the C-2′ position of the pyrrolidine ring or in the N′-methyl group. The $^{14}CH_3$-labeled compound was synthesized by a Wallach–Leuchart reaction. Steam distillation and precipitation with picric acid resulted in a pure dipicrate of $^{14}CH_3$-L-nicotine. The ring-labeled compound, 2′-$^{14}$C-DL-nicotine, was achieved through a five-step process beginning with [7-$^{14}$C]-nicotinic acid. (D.E.B.)

**32268** SYNTHESES OF LABELED COMPOUNDS BASED ON PYRYLIUM SALTS. Balaban, A. T.; Frangopol, M.; Frangopol, P. T.; Gard, E. (Inst. of Atomic Physics, Bucharest). p.45-53 of "EUR-2200.e."

Starting with pyrylium salts, a number of deuterium- and carbon-14-labeled aromatic compounds possessing benzene, naphthalene, pyridine, pyridinium, furan, or azulene nuclei may be prepared. Typical syntheses are presented. (D.E.B.)

**32269** PREPARATION OF TRITIUM OR DEUTERIUM LABELED PEPTIDES AND AMINO ACIDS VIA 2-TRIFLUOROMETHYL-PSEUDO-OXAZOLONES-(5). Weygand, F.; Mayer, D.; Steglich, W. (Technische Hochschule, Munich). p.57-66 of "EUR-2200.e."

A new method is described for the preparation of tritium or deuterium labeled peptides and amino acids. The method consists of incorporating the label in 2-trifluoromethyl-4-R-pseudooxazolone-(5) and reacting with amino acid esters. (D.E.B.)

**32270** SYNTHESIS OF SPECIFICALLY LABELED AMINO ACIDS CONTRIBUTION TO THE ALKYLATION MECHANISM OF MALONE ESTERS. Veres, K.; Benes, J.; Hanus, J.; Prochazkova, V. (Inst. for Biological Research, Czechoslovak Academy of Sciences, Prague). p.67-75 of "EUR-2200.e."

Methods are described for the preparation of amino acids specifically labeled with $^{14}$C, using the alkylation of diethyl acetamido malonate-2-$^{14}$C. (C.H.)

**32271** LABELED MOLECULES FOR STUDIES IN THE CENTRAL NERVOUS SYSTEM. Clark, L. (Univ. of Chicago). p.85-9 of "EUR-2200.e."

Procedures are described for the preparation of $^{14}$C or $^{35}$S labeled organic nitrogen compounds for use in studies of the central nervous system. Certain derivatives of pyridine were found to penetrate the blood-brain barrier and incorporation of a radioisotope labeled atom provided a sensitive and valuable tool for studies of the pharmacological action of isoniazid, a patent anti-tubercular agent; iproniazid, an anti-depressant; nicotinamide, used in the prophylaxis and treatment of pellagra; and pyridine-2-aldoxime methiodide, an antidote for organic phosphate poisoning. Results are included from studies on the distribution and pharmacological action of pyridine-2-aldoxime. (C.H.)

**32272** SYNTHESIS OF SOME PLANT HORMONES OF THE PURINE AND INDOLE TYPE LABELED WITH $^{14}$C AND $^{3}$H AND THEIR APPLICATION. Veres, K.; Benes, J.; Chvojka, L.; Kutacek, M.; Prochazka, Z. (Inst. for Biological Research, Czechoslovak Academy of Sciences, Prague). p.117-26 of "EUR-2200.e."

The preparation of plant hormones of the purine and indole type labeled with $^{14}$C or $^{3}$H is described. These included kinetin (6-furfurylaminopurine), its 6-benzylaminopurine analog, and glycosides of these compounds, which are stimulators of cytokinesis of plant tissues, and indole derivatives of the auxin group. Results are reported from studies on the biological activity and transport of 6-furfurylaminopurine and 6-benzylaminopurine in various species of malus. Observations as to the physiological effects of the kinins in plants are included. (C.H.)

**32273** SIDE REACTIONS DURING DIRECT LABELING WITH TRITIUM. STUDIES WITH SOME SIMPLE COMPOUNDS. Simon, H.; Eder, W.; Medina, R.; Hechtfischer, S. (Technische Hochschule, Munich). p.459-65 of "EUR-2200.e."

Side reactions are described that were observed during the direct labeling of carbohydrates or carbohydrate derivatives with tritium. Examples include the intramolecular tritium distribution and the tritium content in different side products during the preparation of tritium labeled mesotartaric acid, malic acid, hydroxymaleic acid, fumaric acid, and aspartic acid. (C.H.)

**32274** LABELING OF ORGANIC HALIDES IN GAS-CHROMATOGRAPHIC COLUMNS. Elias, H. (Technische Hochschule, Darmstadt, Ger.). p.467-80 of "EUR-2200.e."

The labeling of organic halides by isotopic exchange in gas chromatographic columns is described. Iodine-131, $^{82}$Br, and $^{36}$Cl were used. (C.H.)

**32275** HALOGEN- AND TRITIUM-LABELING BY HETEROGENEOUS EXCHANGE REACTIONS ON GAS CHROMATOGRAPHIC COLUMNS. Stoecklin, G. (Institut fur Radiochemie, Kernforschungsanlage, Julich, Ger.). p.481-93 of "EUR-2200.e."

A number of preliminary experiments are reported in the use of heterogeneous exchange reactions on gas chromatographic columns for the preparation of halogen or tritium labeled organic compounds for use in biological studies. Halogen isotope exchange reactions and non-isotopic halogen exchange reactions are discussed. Exchange data are presented for iodine-fluorine exchange,

in which $^{18}F$ was used as the tracer. Tritium labeling of hydrocarbons by exchange reactions is discussed. (C.H.)

**32276** ABSOLUTE STANDARDIZATION WITH A NaI CRYSTAL BY MEANS OF THE "SUM PEAK" METHOD. CALIBRATION OF $^{176}Lu$. Brinkman, G. A.; Aten, A. H. W. Jr.; Veenboer, J. Th.; Zijlstra, W. G. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/75, 17p. (CONF-650507-32)

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The absolute standardization of radioisotopes emitting two or more $\gamma$ rays in coincidence is possible by means of a NaI(Tl) crystal. If one $\gamma$ ray ($\gamma_1$) occurs for 100%, the absolute activity (N) is given by the following equation: $N = (A_1A_2/A_{12}) + T$. $A_1$ and $A_2$ are the areas under the photopeaks of $\gamma_1$ and $\gamma_2$ ($\gamma_2$ is a $\gamma$ ray that is coincident with $\gamma_1$), $A_{12}$ is the area under the sum peak of $\gamma_1$ and $\gamma_2$, T is the area under the whole spectrum, including the Compton continuum and backscatter peaks. This formula was tested with several isotopes: $^{18}F$, $^{22}Na$, $^{24}Na$, $^{46}Sc$, $^{60}Co$, and $^{88}Y$. All results were in very good agreement (within 5%) with other calibration methods (as $4\pi\beta$ and $4\pi\beta$-$\gamma$ coincidence counting). The method was also used for the standardization of $^{176}Lu$. For $\gamma_1$ and $\gamma_2$, the 306 and 202 kev transitions were used. The measurements were done inside the well of a 60 mm NaI crystal with samples of lutetium-oxide and oxalate, containing 1-3 grams of lutetium. In most of the experiments the source was placed inside a Sn-container, in order to absorb the 56 kev x rays. (P.C.H.)

**32277** RADIOACTIVE DIAMOND AND PROCESS FOR THE PREPARATION THEREOF. Wentorf, R. H., Jr. (to General Electric Co.). U. S. Patent 3,181,933. May 4, 1965. Filed Feb. 28, 1961.

A process is described for preparing radioactive diamond material in which the radioactivity extends throughout the diamond, and the material does not retain a static charge of electricity for any length of time. The diamond material is produced by heating radioactive graphite at a temperature in excess of 1200°C at a pressure in excess of 40,000 atm in the diamond forming region in the presence of a catalyst that is an alloy of Ni and Cr. (B.L.M.)

# Separation Processes and Procedures

**See also Analytical Procedures.**
**ISOTOPE TECHNOLOGY — Separation and Production**

*Refer also to abstract 33590.*

**32278** (AERE-R-4905) INVESTIGATIONS INTO THE USE OF ION EXCHANGE RESINS FOR THE DECONTAMINATION OF RADIOACTIVE EFFLUENT. PART II. PILOT PLANT TRIALS. Clarke, J. H.; White, W. C. J.; Cumberland, R. F.; Wright, T. D. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1965. Dep.; $1.00(BIS); 5s. (HMSO).

An ion exchange process for the treatment of radioactive effluent arising at Harwell, was studied using a 500 gph pilot plant. Average decontamination factors of 1,000 for $\alpha$, and 1,250 for $\beta$ activities were maintained during the treatment of 226,750 gallons. By using a modified regeneration scheme, as devised from laboratory work, the waste arisings from the plant plus those from a pre-filtration stage, were only 2.08% of the throughput. (auth)

**32279** (ANL-7020(p.3-99)) COMPACT PYROCHEMICAL PROCESSES. (Argonne National Lab., Ill.).

Operation and experience with the EBR-II fuel processing facility are described. The development of the skull reclamation process is discussed in detail. Development of advanced pyrochemical processes for fast breeder reactor fuels is also described, and a large amount of data are given on distrubitions and solubilities of fuel constituents in molten alloys and molten salts, and on corrosion problems. Supporting chemical and engineering studies included molten salt systems, critical constants of alkali metals, thermodynamics of lanthanon–cadmium systems and of K–Na alloys, and liquid sodium chemistry. UC and UN were prepared, and the production of PuC–UC and UN–Na paste was attempted. (D.L.C.)

**32280** (ANL-7020(p.100-49)) FUEL CYCLE APPLICATIONS OF VOLATILITY AND FLUIDIZATION TECHNIQUES. (Argonne National Lab., Ill.).

The development of the fluidized-bed fluoride volatility process for enriched fuels is described. Laboratory studies included the recovery of Pu from alumina beds, sorption of $PuF_6$, volatilization of Mo, and fluorination of wastes. Engineering-scale investigations were conducted on the processing of fuels of low- and high-enrichment fuels. Corrosion and fluidization studies are also described. (D.L.C.)

**32281** (HW-SA-3548) THE EXTRACTION OF SULFURIC ACID INTO BENZENE BY TRI-n-OCTYLAMINE. Wilson, Archie S. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 25, 1964. Contract AT(45-1)-1350. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A re-examination was made of the extraction of sulfuric acid by benzene solutions of tri-n-octylamine. The results are in good agreement with a model which involves six amine-containing species in the organic phase. These species are unreacted amine, the monomers of the amine sulfate and bisulfate salts, the dimers of these two salts, and the co-dimer formed from a monomer of each salt. It was found that the amine sulfate salt dimerizes to a much smaller extent than the amine bisulfate salt. (D.L.C.)

**32282** (NAA-SR-10738) OXIDATION-REDUCTION REPROCESSING OF URANIUM CARBIDE REACTOR FUEL. II. BEHAVIOR OF PLUTONIUM AND FISSION PRODUCTS. Smiley, W. G. (Atomics International, Canoga Park, Calif.). June 15, 1965. Contract AT(11-1)-Gen-8. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Experimental data and calculations are presented on the evaporation of plutonium and fission products in the oxidation-reduction pyroprocessing of UC (CARBOX process). The experiments, on the gram scale, included reduction of tracer irradiated $UO_2$ in a graphite crucible, reduction of a U–Ce–Sm–Nd oxide mixture in a tantalum effusion cell, reduction of a U–Ce oxide in a stream of helium, and arc melting tracer irradiated UC. The results indicate that evaporation of plutonium is controlled by the equilibrium pressure, which is proportional to concentration and at least roughly in agreement with Raoult's law. Cerium behaved similarly to plutonium. Evaporation of neodymium was similar to cerium, but removal of samarium was very much larger. Calculations of the plutonium losses to be expected in typical production-scale operations indicate that the loss in the reduction should not be serious, except possibly by deposition on the crucible walls; this possibility should be investigated further. Losses of plutonium in arc casting UC would almost certainly be substantial, so that this method of refabrication can not be used in any fuel cycle which recycles plutonium. The most promising refabrication method appears to be pressing and sintering. Further work on a larger scale and at higher burnup is recommended. (auth)

**32283** (ORNL-TM-1103) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, MARCH 1965. Whatley, M. E.; Haas, P. A.; Horton, R. W.; Ryon, A. D.; Suddath, J. C.; Watson, C. D. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The efficiency of sodium fluoride pellets for removal of

chromium fluoride from a uranium hexafluoride stream was determined. The capacity of pellets having 28% void volume and a surface area of 0.074 $m^2g^{-1}$ was 0.13 g of chromium per g of sodium fluoride, which was 3 times the capacity of another type of pellet having 45% void volume and a surface area of 1 $m^2g^{-1}$. Preliminary testing of mechanical equipment for multi-tube withdrawal from an "egg crate" fuel assembly indicated feasibility for hot cell operation. The thermal conductivity of $UO_2$ fines was measured as a part of a safety study of heat build-up in a basket of sheared fuel during storage. (auth)

**32284** (USNRDL-TR-844) RAPID ISOLATION OF RADIOSILVER AND CERTAIN OTHER RADIOELEMENTS FROM SOLUTION. APPLICATION TO A SEARCH FOR $Ag^{121}$ IN $U^{235}$ FISSION. Weiss, H. V.; Reichert, W. L. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 11, 1965. Contract AT(49-2)-1167. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Rapid separation of silver from cadmium, indium, and tin was effected by filtration through a thin bed of copper powder. This method was applied to a search for $^{121}Ag$ in the thermal neutron fission of $^{235}U$. None was detected and this result indicated that either the half life of $^{121}Ag$ is substantially shorter than the post-fission separation time of 3.5 sec or its yield is inordinately low. The study was extended to examine the behavior of an additional number of elements in the separation. Of the 28 elements studied, only palladium, silver, gold, and mercury were removed from solution to the extent of 70% or more. Selenium, ruthenium, tellurium, and iodine were partly retained by the copper to the extent of 5-33%. Of the remaining 20 metals, with the exception of zirconium and arsenic, appreciably less than 0.1% of the element adhered to the filter bed. This selectivity may allow wider application of the method. (auth)

**32285** CATION EXCHANGE SEPARATION OF URANIUM FROM BISMUTH IN HYDROCHLORIC ACID-ISOPROPANOL MEDIUM. Korkisch, Johann; Ahluwalia, S. S. (Universitat, Vienna). Anal Chem., 37: 1009-12(July 1965).

A method for the simple and rapid separation of small quantities of uranium from a large excess of bismuth was described. By using a medium consisting of 90% isopropanol and 10% 6N hydrochloric acid, uranium(VI) was completely retained on a small column of the strongly-acid cation exchange resin Dowex 50, whereas bismuth as the anionic chloride complex passed into the effluent unadsorbed. For the elution of uranium, 4 to 12N hydrochloric acid was employed. This method can be used for the routine determination of uranium in bismuth containing amounts of uranium ranging from a few micrograms to milligrams. Because several other metal ions such as vanadium, molybdenum, zinc, cadmium indium, etc., show a behavior similar to that of bismuth, their ready separation from uranium can also be effected. (auth)

**32286** CHEMICAL PROCESSES AND NUCLEAR FUELS. Fletcher, J. M. Chem. Brit., 1: 256-60(June 1965).

The chemical processes for treatment of nuclear fuels involve two sequences. The ore concentrates (largely $U_3O_8$) were converted to nuclear fuels, uranium metal or dioxide. The nuclear fuels, after removal from reactors, were treated for the recovery of useful constituents such as plutonium or fission-product strontium. The production of nuclear fuels from ore concentrates occurs in five stages: dissolution in nitric acid; purification as uranyl nitrate by solvent extraction; conversion of uranyl nitrate to uranium dioxide; hydrofluorination of the dioxide to tetrafluoride; and reduction of tetrafluoride to metal. The chemical processing of irradiated fuels involves a number of important steps. Solutions of uranyl and other nitrates from dissolution of the fuel in nitric acid were treated by solvent extraction to separate the uranium and plutonium from the fission products. The properties of many metal nitrates, in solution in aqueous and organic phases and as solids are discussed, along with the solvent–extraction processes, using tributyl phosphate in a hydrocarbon. The separation by solvent extraction of the longer-lived fission products e.g., cesium, cerium, strontium, zirconium, and ruthenium in relation to the recovery of uranium and plutonium is also discussed. (F.J.H.)

**32287** THE EXTRACTION OF RUTHENIUM NITROSOPENTAHALIDE COMPLEXES BY ALIPHATIC AMINES. Sinitsyn, N. M.; Zvyagintsev, O. E.; Travkin, V. F. (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 160: 370-2 (Jan. 11, 1965). (In Russian)

The following nitroso ruthenium complexes tagged with $^{106}Ru$ were synthesized: $(NH_4)_2[Ru\ NOCl_5]$, $(NH_4)_2[Ru\ NOBr_5]$, and $(NH_4)_2[Ru\ NOI_5]$. The following long-chain, aliphatic amines were used as extractants: $(n\text{-}C_8H_{17})_3N$, tri-n-octylamine (TOA); $(n\text{-}C_6H_{13})_2NH$, di-n-hexylamine (DHA); and $(n\text{-}C_{12}H_{25})NH_2$, n-dodecylamine (DDA). The purpose of the study was to determine the effect of the amine structure and of the acid ligand in the ruthenium complex on the extractability of the Ru compound. The results of the extraction of a 0.005M solution of the Ru salt in 1.0M acid by the above amines showed that the tertiary amine TOA was more effective than the secondary amine DHA, which in turn extracted the Ru complex more efficiently than the primary amine DDA. On investigating the effect of the nature of the acid ligand on the extractability of nitroso ruthenium complex, all extractions were performed from a 1.0M $HNO_3$ aqueous phase in order to eliminate the effect of halide complexing. The chloride complex was extracted better than the bromide complex, which in turn was extracted more readily than the iodide complex. A plot of the log of the distribution coefficient versus the log of the concentration of free TOA in the organic phase gave a straight line. The compounds extracted into the organic phase were isolated and analyzed. It was found that two molecules of amine are associated with one molecule of the ruthenium nitroso complex. (TTT)

**32288** THE RADIOCHEMICAL SEPARATION OF SOME METALS BY PARTITION CHROMATOGRAPHY WITH REVERSED PHASES ON TEFLON IN THE SYSTEM TRI-N-OCTYLAMINE-ELECTROLYTE. Mikulski, J.; Stronski, I. (Inst. of Nuclear Physics, Krakow). J. Chromatog., 17: 197-200(July 1965).

Partition chromatography of metal halide mixtures on teflon using tri-N-octylamine–hydrochloric acid systems was studied. Radioactive tracers were used to determine metal separation. $CaCl_2$, $MnCl_3$, $FeCl_3$, $CoCl_2$, $NiCl_2$, $CuCl_2$, $ZnCl_2$, $SiCl_2$, $YCl_3$, $CdCl_2$, $ThCl_4$, $PaCl_5$, and $UO_2Cl_2$ were used in the studies. Data are presented in graphs. (M.C.G.)

**32289** SYNERGIC EFFECTS IN SOLVENT EXTRACTION. VII. DIVALENT COBALT, ZINC AND COPPER. Irving, H. M. N. H.; Edgington, D. N. (Univ. of Leeds, Eng. and Oxford Univ.). J. Inorg. Nucl. Chem., 27: 1359-67(June 1965).

With $^{60}Co$, $^{64}Cu$, and $^{65}Zn$ as tracers, the solvent extraction of their divalent ions from hydrochloric acid — sodium acetate buffers into mixtures of 1,1,1-trifluoro-3,2′-thenoylacetone (TTA) with tributyl phosphate (TBP) or tri-n-butyl phosphine oxide (TBPO) in cyclohexane was studied. The extraction coefficient was found to be greater for such mixtures than for either component alone and the extractable species were identified as $CoX_2 \cdot TBP$ and $CoX_2 \cdot 2TBP$, $CuX_2 \cdot TBP$ and $CuX_2 \cdot TBPO$, and $ZnX_2 \cdot TBP$ (where HX = TTA). The probable structure of these co-ordination compounds is discussed and several equilibrium constants are reported. (auth)

**32290** SEPARATION FACTORS FOR SOLVENT EXTRACTION PROCESSES. THE SYSTEM OF 1M DI-(2-ETHYLHEXYL) PHOSPHORIC ACID (IN AMSCO 125-82)-Pr-Nd SALTS AS AN EXAMPLE. Goto, T.; Smutz, M. (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 27: 1369-79(June 1965).

The separation factors of Nd with respect to Pr for 1M di-(2-ethyl-hexyl) phosphoric acid in Amsco 125-82 were obtained for perchlorate, chloride, nitrate, and chloride-nitrate systems. It was shown that the separation factors

can be expressed by an equation that consists of two parts: the separation ability of the solvent itself and the ligand-dependent term. The former is the ratio of the equilibrium constants for the extraction reaction, and the latter is the fraction of the Nd present that is in the completely ionized form ($Nd^{3+}$, the extractable species) divided by the fraction of Pr present that is completely ionized. (auth)

**32291** DISTRIBUTION STUDIES OF TRIPROPYL PHOSPHATE BETWEEN DIFFERENT ORGANIC DILUENTS AND WATER. **Dyrssen, D.; Petkovic, Dj. (Royal Inst. of Tech., Stockholm and Universitat, Gothenburg).** J. Inorg. Nucl. Chem., 27: 1381-93(June 1965).

The distribution of radioactive $(PrO)_3PO$ (tripropyl phosphate) between water and the following mixtures of organic diluents was measured at 25°C: carbon tetrachloride, methylisobutyl ketone (hexone), tributyl phosphate (TBP), tripropyl phosphate (TPP), and chloroform with hexane, and hexone, tributyl phosphate, and chloroform with carbon tetrachloride. These experiments showed the following order of interaction between TPP and the solvents: chloroform (5.4) > TBP (2.4) > hexone (1.0) > carbon tetrachloride (0.8) > hexane. The numbers refer to the constants K of the following equilibrium in water-saturated hexane: TPP + S ⇌ TPP · S. Additional distribution experiments were made with hexane or carbon tetrachloride and nitric acid or sodium hydroxide solutions. Since the distribution measurements indicated that the interaction between trialkyl phosphates and the diluents depends mainly on the PO group, it was suggested that the distribution data for TPP can be used to estimate the activity of TBP in solvent mixtures. The results were in good agreement with vapor pressure measurements by Rozen et al. of TBP mixtures with hexane and carbon tetrachloride. Infrared measurements on TBP in different diluents show a definite influence of carbon tetrachloride, TBP, hexone, and chloroform on the PO stretching vibration of TBP. Using TBP-hexane mixtures and K = 2.4 the absorbance peaks of the TBP monomer and an unsplit peak of $(TBP)_2$. (auth)

**32292** THE EXTRACTION OF THORIUM FROM SULPHURIC ACID SOLUTIONS BY DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID. Sato, Taichi (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. Nucl. Chem., 27: 1395-1403(June 1965).

The partition of thorium (IV) between aqueous sulfuric acid and solutions of di-(2-ethylhexyl)-phosphoric acid (DEHPA) in kerosene was investigated; the infrarred spectra of the organic phases were studied. The effects of organic solvent and of the addition of tri-n-butyl phosphate (TBP) on this extraction system were also examined. The mechanism of extraction is discussed in the light of the results. (auth)

**32293** SORPTION PROPERTIES OF ZIRCONIUM PHOSPHATES OF VARIOUS CRYSTALLINITIES. Nancollas, G. H.; Pekarek, V. (Glasgow Univ.). J. Inorg. Nucl. Chem., 27: 1409-18(June 1965).

Various zirconium phosphate samples, ranging from amorphous to very good crystalline material, were prepared. X-ray powder photographs are presented and the d-values tabulated. From the results of capacity measurements, sorption properties of ions of various valencies, and titration curves, possible formulas for the preparations are proposed. (auth)

**32294** A STUDY OF URANYL PHOSPHATES. IV. SORPTION OF SOME FOUR-VALENT CATIONS ON AMMONIUM URANYL PHOSPHATE. **Vesely, V.; Pekarek, V. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez).** J. Inorg. Nucl. Chem., 27: 1419-25 (June 1965).

The dependence on the concentration of uranyl and ammonium ions for the sorption of thorium, plutonium, and zirconium ions on ammonium uranyl phosphate was investigated. By considering a precipitation mechanism of sorption equations were derived, which are valid for the solution in contact with the sorbent. From the results obtained the approximate composition of the phosphates formed at sorption was found and approximate values of their solubility products were determined. (auth)

**32295** SOLVENT EXTRACTIONS FROM MOLTEN SALTS. IV. KINETICS OF THE FORMATION OF MERCURY(II) BROMIDE SPECIES. Zangen, M. (Soreq Research Establishment, Yavne, Israel). J. Phys. Chem., 69: 1835-9(June 1965).

The partition of $HgBr_2$ between a polyphenyl eutectic mixture and a molten $LiNO_3-KNO_3$ eutectic at 150°C was measured as a function of time for various concentrations of KBr added to the salt melt. From the results, the rate constants for the following reactions were calculated: $(HgBr_2)_{polyphenyl} \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} (HgBr_2(NO_3)_2^{2-})_{salt}$, $k_1 = 2.7 \pm 0.1 \times 10^{-3}$ sec$^{-1}$ and $k_{-1} = 2.5 \pm 0.2 \times 10^{-2}$ sec$^{-1}$; $(HgBr_2(NO_3)_2^{2-} + Br^- \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} HgBr_3(NO_3)^{2-} + \text{solvent})_{salt}$, $k_2 = 1.3 \pm 0.2 \times 10^{-1}$ kg mole$^{-1}$ sec$^{-1}$ and $k_{-2} = 1.6 \pm 0.2 \times 10^{-2}$ sec$^{-1}$; and $(HgBr_3(NO_3)^{2-} + Br^- \underset{k_{-3}}{\overset{k_3}{\rightleftharpoons}} HgBr_4^{2-} + \text{solvent})_{salt}$, $k_3 = 6.2 \pm 1.0 \times 10^{-2}$ kg mole$^{-1}$ sec$^{-1}$ and $k_{-3} = 6.9 \pm 1.0 \times 10^{-3}$ sec$^{-1}$. The last two equations were found to operate simultaneously in the exchange of $^{82}Br$ between $HgBr_2$ and KBr in the above system. (auth)

**32296** REFINING YTTRIUM IN A VACUUM. Ivanov, V. E.; Vorobyov, V. V.; Balenko, E. P. (Khar'kov State Univ.). Ukr. Fiz. Zh., 10: 543-8(May 1965). (In Ukrainian)

The efficacy of purifying yttrium in a column with a temperature gradient during sublimation was investigated. Evaporation occurred at a temperature of 1450° at a rate of $10.16 \cdot 10^{-6}$ g cm$^{-2}$ sec$^{-1}$ at a residual gas pressure in the chamber of $(2-3) \cdot 10^{-6}$ mm Hg column. A distillate was obtained with a small content of Al, Mg, Si, Cu, Fe, Cr. The column with the temperature gradient may be used for separating rare-earth metals. A procedure is described for carrying out spectral analysis of yttrium for the content of several ordinary and rare-earth impurities simultaneously. (auth)

**32297** EXTRACTION OF THORIUM, PROTACTINIUM, URANIUM AND NEPTUNIUM BY HYDROXYLAMINE DERIVATIVES. Lapitskii, A. V.; Rudenko, N. P.; Saed, Abdel Gavad. Vestn. Mosk. Univ., Ser. II, Khim., No. 2, 25-9(Mar.-Apr. 1965). (In Russian)

Solvent extraction of $^{234}Th$, $^{233}Pa$, $^{239}Np$, and natural mixtures of U by means of benzoylhydroxylamine, N-benzoylphenylhydroxylamine, and N-nitrosonaphthylhydroxylamine (neocupferron) was carried out at 25 ± 0.1°C. The curves of the extraction of Th, Pr, Np, and U by the acids in hexanol were plotted as a function of pH. The data obtained can be used in developing procedures for preparation of chemically pure carrier-free isotopes. (R.V.J.)

**32298** CO-PRECIPITATION OF PLUTONIUM WITH LANTHANUM OXALATE. Grebenshchikova, V. I.; Bryzgalova, R. V.; Chernitskaya, I. V. p.26-30 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

It was that at 50°C Pu is coprecipitated with lanthanum oxalate, forming anomalous mixed crystals with enrichment of the solid phase, but less than in precipitation at 20°C. The distribution of Pu(IV) between lanthanum oxalate and solution in isothermal supersaturation release followed the logarithmic law of Duerner and Hoskins. Increase of concentration of the oxalic acid in the solution caused a gradual decrease of the actual concentrations of Pu(IV) participating in the isomorphic exchange and therefore a decrease of the crystallization coefficient of Pu. It was established that for the system investigated $La_2(C_2O_4)_3 \cdot 8H_2O-Pu(C_2O_4)_2-HNO_3-H_2C_2O_4(HNO_3$ is 1.5N) there is no linear relation between the crystallization coefficients and the proportion of solution components. (tr-auth)

**32299** CO-PRECIPITATION OF PLUTONIUM WITH LANTHANUM OXALATE. Grebenshchikova, V. I.;

Bryzgalova, R. V.; Chernitskaya, I. V. p.30-4 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

It was found that in mixed solutions of nitric acid and ammonium oxalate at 50°C plutonium forms anomalous mixed crystals with lanthanum oxalate. The absence of relation between the changes in the crystallization coefficients of Pu and the proportion of solution components was established. In the system given the basic factors determining the size of the crystallization coefficients seemed not to be the proportion of the solution components, but the change in the degree of complex formation by Pu(IV) in the solution. (tr-auth)

**32300** CO-PRECIPITATION OF Ce WITH $K_2SO_4$ CRYSTALS. IV. EFFECTS OF IMPURITIES ON Ce PRECIPITATION. Melikhov, I. V.; Kirkova, E. K.; Babayan, S. G. p.34-43 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The presence of upper and lower limits of adsorption of Ponceau on the surface of stable crystals of $K_2SO_4$ was shown. The upper limits showed saturation of the crystal surface with oriented molecules of the dye. A sharp difference was found in the adsorptive properties of stable and finely dispersed crystals of $K_2SO_4$. The relation of the lower limit of adsorption with precipitation of cerium with growing crystals of $K_2SO_4$ was determined. (tr-auth)

**32301** CO-PRECIPITATION OF Ce WITH $K_2SO_4$ CRYSTALS. VII. CAPTURE OF Ce BY $K_2SO_4$ CRYSTALS GROWING IN NITRIC ACID SOLUTIONS. Melikhov, I. V.; Gerts, Z.; Babayan, S. G. p.42-50 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

It was shown that the coprecipitation of Ce with $K_2SO_4$ during isothermal saturation of nitric acid solutions with $K_2SO_4$ occurs in three steps. In the first step the coefficient of capture of impurities in crystallizing masses of $K_2SO_4$ increases. In the second step it decreases. The character of the third step of co-precipitation was not established. The experimental data can be explained by the model according to which the diffusion of Ce into the solution affects the coprecipitation, rapid and slow adsorptive processes proceed on the surface of $K_2SO_4$, and acids change all surface processes and alter the conditions of impurities in solution, reducing their capacity to be adsorbed on the surface of solid phases. (tr-auth)

**32302** KINETIC METHOD FOR STUDYING THE MECHANISM OF CO-PRECIPITATION AND TRANSITION OF Ce AND La INTO $K_2SO_4$ CRYSTALS. Melikhov, I. V. p.51-9 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The dependence of the distribution factors in coprecipitation on some coagulation of particles of the solid phase was studied. In the systems $K_2SO_4$–La and $K_2SO_4$–Ce it was shown that the method given makes it possible to analyze the complex process of coprecipitation into the elementary steps and reveals the possibility of investigating each stage independently of all others. (tr-auth)

**32303** CO-PRECIPITATION OF ASTATINE WITH DIFFICULT-SOLUBLE PRECIPITATES OF ONE-VALENCE CATIONS. Ang, Fu-chun; Krylov, N. G.; Norseev, Yu. V.; Chao, Tao-nan; Khalkin, V. A. p.80-8 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

Astatine, oxidized with bichromate and nitric acid solutions, co-precipitates with $Tl_2Cr_2O_7$, $Ag_2Cr_2O_7$, the phosphotungstate and phosphomolybdate of cesium, and $AgIO_3$. All the salts, except silver bichromate, adsorb astatine thoroughly from nitric acid solution. This property of the element confirmed previous conclusions on the existence in solutions of monovalent astatine cations. (tr-auth)

**32304** PURIFICATION OF URANYL NITRATE BY ZONAL RECRYSTALLIZATION. Spytsyn, Vikt. I.; Kirgintsev, A. N.; Avvakumov, E. G.; Kuleshov, I. M. p.88-91 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

Investigations of the distribution of $^{234}Th(UX_1)$ and the sum of the fission products between solid and liquid phases during directed crystallization of uranyl nitrate hexahydrate showed that the method of zonal recrystallization can be used for the purification of uranyl nitrate and for the concentration of radioactive impurities. (tr-auth)

**32305** STUDIES OF THE SECOND ADSORPTION OF EUROPIUM ON $BaSO_4$. I. EFFECTS OF THE PRECIPITANT ION ON THE ADSORPTION ISOTHERM. Ishina, V. A.; Frenklikh, M. S.; Nechaev, B. P. p.91-6 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The secondary adsorption of trace amounts of europium ($\sim 10^{-8}$ M) on crystals of $BaSO_4$ for different excesses of $SO_4^{2-}$ in solution was investigated. It was found that the dependence of the coefficient of adsorption on the percentage of $SO_4^{2-}$ agrees with the Ratner equation. The equilibrium distribution of Eu between the precipitate and the saturated solution of $BaSO_4$ at $\underline{M}SO_4^{2-} = 1.5 \times 10^{-4}$ and Eu concentrations in the interval from $10^{-8}$ to $10^{-4}$ M was investigated. It was found that the isotherm found obeys the Freundlich isotherm. (tr-auth)

**32306** STUDIES OF THE SECOND ADSORPTION OF EUROPIUM ON $BaSO_4$. II. EFFECTS OF VARIOUS CATIONS. Ishina, V. A.; Frenklikh, M. S. p.96-103 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The effect of cation impurities of different valencies and chemical natures on the adsorption of Eu on crystals of $BaSO_4$ was investigated. On the basis of the Ratner theory of secondary adsorption the equation of adsorption in the presence of competing ions of any valency was investigated. It was found that in the presence of $Na^+$, $Mg^{2+}$, and $Al^{3+}$ desorption takes place in agreement with this theory, but the effects of $La^{3+}$ and $Th^{4+}$ on desorption seemed anomalously high. This was connected, apparently, with the low solubility of sulfuric acid salts of these elements in water. (tr-auth)

**32307** THE MECHANISM OF La, Eu, AND Sc CAPTURE BY IRON HYDROXIDE. Grebenshchikova, V. I.; Prokudina, A. F. p.103-9 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The mechanism of the sorption of the trivalent elements, prone to hydrolysis, on precipitants of iron hydroxide was determined for different concentrations of hydrogen ions in solution. In the area of a high concentration of hydrogen ions, where maximum and irreversible sorptions were observed, the sorption mechanism apparently resulted from chemical interactions of hydroxide ions of the surface of molecules of colloidal $Fe(OH)_3$ with hydrolyzed ions of the type $R(OH)_3^+$. At low pH values, were irreversible sorption occurred, the exchange character of the sorption prevails, during which both $R^{3+}$ and $R(OH)^{2+}$ ions can be exchanged with hydrogen ions of the hydroxide group $Fe(OH)_3$. (tr-auth)

**32308** RADIOCOLLOIDS IN SORPTION SYSTEMS. Egorov, Yu. V. p.117-22 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

It was assumed that radioactive microcomponents in radiocolloidal condition represent a heterogeneous sorption agent, the absorption of which with solid collectors is accompanied by thermal effects, functionally combined with the extent of sorption. The sorption isotherm of such heterogeneous microcomponents was investigated for systems with different masses of the sorbent. Recommendations for the practical determination of the parameters of the suggested isotherm and verification of its accomplish-

ment were worked out. As an example of the applicability of the isotherms the sorption of $^{144}Ce$ on vermiculite from a solution of sodium nitrate was studied. (tr-auth)

**32309** SORPTION OF POLONIUM BY FLUOROPLAST-4. Starik, I. E.; Ampelogova, N. I. p.123-7 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

During the study of the sorption of Po from hydrochloric acid solution on fluoroplast-4, it was found that the magnitude of the sorption seems to be a function of the state of the Po in the solution and abruptly increases with the appearance in the solution of polonium hydroxy complexes. Chloride complexes of Po, as well as the nitrate and perchlorate complexes with fluoroplast-4 were sorbed insignificantly. The presence of neutral salts exerted a salting out effect on the sorption of Po as hydroxy complexes and reduced the sorption of chloride complexes of Po. The behavior of Po in sorption and extraction processes was determined by its state in the solution. (tr-auth)

**32310** SORPTION OF RADIOACTIVE ELEMENTS FROM SOLUTIONS. II. SORPTION OF $^{110}Ag$ ON FLUORINATED SURFACES OF L-36 GLASS AND QUARTZ. Rozovskaya, N. G. p.127-33 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The effects of processing surfaces of L-36 glass and quartz with fluoriding agents on its adsorptive capacities with respect to cations ($Ag^+$) were studied. It was established that during the interaction of hydrofluoric acid with the surface of these glasses substitution of the functional hydroxyl group with ions of the fluorine occurs. The magnitude of the adsorption on the fluorinated surface of the quartz glass did not exceed on the average 30% of the magnitude of the adsorption on non-modified surfaces. It was shown that the result of the interaction of the HF vapor and solutions of ammonium fluoride on L-36 glass depends on the state of the surface of the glass. The interaction of the HF vapor and $NH_4F$ solutions on L-36 glass with a minimum possible surface layer led to reduced adsorptive properties of the glass. HF vapor, solutions of ammonium fluoride, and weak HF solutions during interactions on L-36 glass with strongly hydrated surfaces (the presence of thick surface layers) increased its adsorbing capacity with respect to $Ag^+$ cations; the increase of the adsorption is explained by the increase of the porosity of the surface layers and, possibly, by the formation on the surface of films of corrosion products. The effect of the concentrated (10 to 35%) HF solutions on L-36 glass did not depend on the state of its surface, which can be explained by the complete destruction of surface structure of the layer which leads, as was shown earlier, to reduced ion exchange properties of the glass (tr-auth)

**32311** ADSORPTION OF RADIOACTIVE ISOTOPES FROM MIXED SOLUTIONS. Starik, I. E.; Sheidina, L. D.; Ginzburg, F. L. p.144-9 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

Investigation of the sorption of Cs, Pu, and Pa on glass, fluoroplast-4, and metals from aqueous, water-alcohol, and water-acetone solutions showed that in 0.1N $HNO_3$ the increase of the percentage of acetone in the solution of 90% did not exert noticeable influence on the sorption of Cs and Pu, but significantly increased the sorption of Pa. In less acid solutions the sorptive behavior of the elements investigated was complexly dependent on the concentration of the acetone and the nature of the sorbents. The sorption of Pu and Pa in water–alcohol solutions (0.1 to 0.01N $HNO_3$) was of the same order of magnitude as in the sorption from aqueous solutions. (tr-auth)

**32312** SORPTION ISOTHERMS OF URANYL SULFATE COMPLEXES BY VARIOUS BASE ANION-EXCHANGE RESINS. Laskorin, B. N.; Slesareva, D. D. p.158-61 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The change in the sorptive capacity of anionites with changes in the equilibrium concentration of uranium in the solution in the range from 0.01 to 0.32M (at constant concentration of the sulfate and solution pH) is well described by the Freundlich equation. The form of the uranyl sulfate complexes sorbed depends on the complete exchange capacity of the anionite and equilibrium concentration of uranium in the solution. (tr-auth)

**32313** MECHANISM OF URANIUM SORPTION FROM URANYL FLUORIDE SOLUTIONS BY ANION EXCHANGE RESINS. Pakholkov, V. S. p.162-5 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

On the basis of the determination of the molar relation of the quantity of chlorine displaced from the anionite to the quantity of uranium sorbed by it and the molar ratio $F^-$: $UO_2^{2+}$ in the ionite phase and in the sulfate, it was established that the elements specified were sorbed from stoichiometric neutral solutions of uranyl fluoride in the form of the monocharged anion complex $UO_2F_3^-$. In the stages determined for the processes of sorption for high uranium concentrations in the ionite phase, the complication of sorbing ions occurs because of the hydrolysis and complex formation. The insignificant degree of desorption of $UO_2F_2$ in aqueous solutions and the passage of uranium into the sulfate in the form of the most stable complex ions $UO_2F^+$ confirmed the sorption mechanism established on the basis of the analysis of output curves, by which neutral molecules of uranyl fluoride are added to the fluorine ions of the ionite with formation of complex anions. (tr-auth)

**32314** SORPTION OF URANIUM(VI) FROM HYDROFLUORIC ACID SOLUTIONS BY WEAK-BASE ANION EXCHANGE RESINS EDE-10P AND AN-2F. Pakholkov, V. S.; Stikhin, V. F. p.165-9 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The sorption of uranium from solutions of $UO_2F_2$–HF on the weakly basic anionites EDE–10P and AN–2F was investigated. It was established that both of the anionites investigated were characterized by the same behavior during sorption. By use of the anionites in the chlorine form, the quantitative extraction of uranium is possible only under the condition of the presence in the original solution of free acid: the molar ratio $UO_2^{2+}$: $F^-$ in it is probably 1:4. With anionites of the fluoride form uranium is sorbed from solutions of uranyl fluoride with any percentage of HF. The washing out of uranium from uranium-saturated EDE–10P and AN–2F was investigated with the solutions 1N $HNO_3$, 0.9N $NH_4NO_3$ + 0.1N $HNO_3$, 1N $NH_4NO_3$, and water. (tr-auth)

**32315** SORPTION OF URANIUM(VI) FROM HYDROFLUORIC ACID SOLUTIONS BY STRONG-BASE ANION EXCHANGE RESINS AV-17. Pakholkov, V. S. p.169-74 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The sorption under dynamic conditions of uranium(VI) from $UO_2F_2$ solutions was investigated as a function of the concentration of hydrofluoric acid using the anionite AV-17 in the chloride and fluoride form. The fact of the absorption of uranium(VI) above the exchange capacity of ionite was established. This was explained by the hydrolysis of the uranyl ions in the solution and in the ionite phase and by complex formation. The effect of the concentration of the uranium in the original solution on the sorptive capacities of the anionite was investigated. It was established that the sorptive capacity increased with increasing concentrations of uranium from 3.82 mM $UO_2^{2+}$/g for 0.0125M $UO_2F_2$ solution to 4.68 mM $UO_2^{2+}$/g for 0.0750M solution. From the analysis of the output curves of the sorption with the ionites in the chloride and fluoride forms, the conditions for the sorption of uranium without passage were confirmed and a sorption mechanism was proposed. (tr-auth)

**32316** SORPTION OF URANIUM(VI) FROM $H_2SO_4$–HF SOLUTIONS BY ANION EXCHANGE RESINS. Pakholkov, V. S. p.174-8 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The sorption of uranium(VI) from $H_2SO_4$ solutions on the anionites AB–17, EDE–10P, and AN–2F was investigated under dynamic conditions. It was established that the addition of hydrofluoric acid increased the sorptivity for uranium by 2 to 3 times in comparison with the sorptivity determined for pure sulfate solutions. The increase of the sorptivity with increase of the HF concentration was explained as the sorption of uranium principally in the form of monovalent fluoride complex anions, $UO_2F_3^-$. (tr-auth)

**32317** SORPTION OF URANIUM(VI) FROM HCl–HF SOLUTIONS BY ANION EXCHANGE RESINS. Pakholkov, V. S. p.178-83 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The sorption of uranium(VI) from HCl–HF solutions on the anionites AB–17, AV–16G, EDE–10P, and AN–2F was investigated under dynamic conditions. It was established that the addition of hydrofluoric acid to the hydrochloric acid uranyl solutions abruptly increased the sorptivity of the uranium because of the appearance in the solution of monocharged complex anions $UO_2F_3^-$. It was established that the uranium is not washed from the anionites with dilute solutions of chloride with the addition of HF. With respect to the capacity for regeneration, the anionites could be arranged in the following series: AV–17 > AV–16G > EDE–10P > AN–2F. (tr-auth)

**32318** SORPTION OF CURIUM, LANTHANUM, ERBIUM, AND YTTERBIUM FROM LITHIUM CHLORIDE SOLUTIONS BY AV-17 ANION EXCHANGE RESIN. Bochkarev, V. A.; Lbov, A. A. p.190-4 of "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov." Moscow and Leningrad, Izdatel'stvo "Nauka," 1965. (In Russian)

The distribution coefficients of La, Yb, and Cm between lithium chloride solutions and the anion exchange resin AV-17 were determined as a function of the LiCl and HCl concentrations and the temperature. The distribution coefficients of La, Er, Yb, and Cm from lithium chloride solutions, containing ethyl alcohol, were determined. An increase of the percentage of alcohol in the eluent to 15% significantly increased the distribution coefficient of Cm and only slightly affected the distribution coefficient of La. The optimum conditions for the separation of trace additions of Cm and Am were selected: concentration of lithium chloride 10M, hydrochloric acid 0.1M, ethyl alcohol ~15 ml/100 ml solution, and temperature 60°C. For these conditions the distribution coefficient $D_v(Cm)/D_v(La)$ is 35. It was established that the resin AV-17 can be used for the successful separation of trace quantities of the transplutonium and rare earth elements. (tr-auth)

**32319** PROCESS FOR THE PURIFICATION OF URANIUM AND PARTICULARLY IRRADIATED URANIUM AND DEVICE FOR THE PRACTICAL OPERATION OF THE PROCESS. Erler, Jean; Peray, Robert; Petit, Jean (to Commissariat à l'Énergie Atomique). British Patent 980,198. Jan. 13, 1965. Priority date Mar. 18, 1961, France.

A process and device are provided for the purification of U, particularly U that was irradiated. The device includes a crucible of good heat-conducting metal with water-cooling means. An appropriate slag and an electrode of the U to be purified are placed in the crucible. Means are provided for the downward movement and automatic position adjustment of the U electrode in the slag. A second electrode of W may provide means for melting the slag. Means are provided for supplying slag that is a nearly eutectic mixture of BeO and at least one other oxide that has a higher thermal stability and is chosen from the oxides of Ba, Ca, Sr, Li, and La. About 4% of $UO_2$ may also be added to the slag. The U to be purified is melted by appropriate means under the slag. The molten mass is then cooled to a temperature that is between the melting point of the U and that of the slag. The solid purified U is then separated by a suitable method from the liquid slag that contains the impurities. (B.L.M.)

**32320** PROCESS FOR THE PRODUCTION OF BERYLLIUM SULPHATE. Turovschi, Victor; Popa, Ovidiu (to The Deputy Minister in the Roumanian Ministry of Petroleum and Chemical Industry). British Patent 992,803. May 19, 1965. Filed Aug. 15, 1961.

In the process described, beryl is decomposed by melting with soda, the melt is treated with sulfuric acid, and silicon dioxide is removed. The solution of Be, Al, and Na sulfates thus obtained is concentrated to incipient crystallization. Adjustment of the pH to 8.5-9 precipitates the Be and Al as hydroxides and the sodium sulfate is washed out with water. The hydroxides are dissolved by sulfuric acid and Al is separated out as alum leaving beryllium sulfate in solution. (A.G.W.)

**32321** URANIUM RECOVERY PROCESSES. Fletcher, John Molyneux; Wain, Arthur Gregory; Keen, Norman James (to United Kingdom Atomic Energy Authority). U. S. Patent 3,171,713. Mar. 2, 1965. Priority date Apr. 26, 1960, Great Britain.

In a process for recovering U from a Zr alloy containing 1–50% by weight of U, the alloy is dissolved in an aqueous solution containing HF and KF and having a total initial fluorine content of at least 12 g-atoms/l. A precipitate consisting of a mixed fluoride of K and U is then separated from the solution. (A.G.W.)

**32322** PROCESS FOR LEACHING URANIUM-BEARING ORES. Peter, Philip W. U. S. Patent 3,183,058. May 11, 1965. Filed June 30, 1961.

A process is described for leaching lignite or other U-bearing carbonaceous ores, which when wetted, become coated with oily films impervious to direct leaching. The oily film may be destroyed either by electrolytic or chemical reduction to expose the ore that then may be leached by conventional methods. The reduction of the film may be carried out as a preliminary step or concurrently with subjection of the ore to leaching. The leaching step may use either sulfuric or other mineral acid or sodium or other basic carbonate, depending on whether acid or basic carbonate leaching is better suited for the ore to be treated. If chemical reduction is employed, the reducing agent and the leaching agent must be compatible if the processes are carried out simultaneously. Water soluble reducing agents, such as $Ca(HSO_3)_2$, are particularly suitable for the chemical reduction to break the film; however, it is also possible to use an insoluble agent, such as $H_2$, by bubbling it through the slurry. The acid or carbonate leaching agents are suitable electrolytes for the electrolytic reduction. During the destruction of the oily film, the U may be reduced to U(IV); however, the U(IV) can be reoxidized to U(VI) with $MnO_2$ for acid leaching or $KMnO_4$ for carbonate leaching. (B.L.M.)

**32323** RECOVERY OF PLUTONIUM AND/OR URANIUM VALUES FROM AQUEOUS SOLUTIONS. Matheson, Arthur R. (to U. S. Atomic Energy Commission). U. S. Patent 3,195,977. July 20, 1965.

A method is described for recovering plutonium from a solution containing plutonium, trivalent chromium, and aluminum. An oxidizing agent is added to oxidize the plutonium and chromium to their hexavalent state; the resulting solution is incorporated into an aqueous alkali metal hydroxide solution in the presence of a uranyl salt; and the resulting precipitate of alkali metal uranate and plutonium values carried thereby is separated from the solution. (AEC)

# ENGINEERING

## General

*Refer also to abstract 32048.*

**32324** (AERE-M-1568) A WORKSHOP SCHEDULING PROCEDURE. Nicholson, T. A. J. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 28p. Dep.; $0.80(BIS), 4s. (HMSO).

A procedure is described to schedule jobs through a workshop. Each of the jobs consists of a specified sequence of operations, and the procedure is designed to order these operations through the machines efficiently in terms of a management objective. The usual objective is to complete the work in the minimum time, but three objectives are distinguished. The procedure does not necessarily provide an optimal scheduling, but it should be near optimal. It is essentially simple and easy to implement. (auth)

**32325** (CONF-650201(p.69-80)) ECONOMICS OF LOCATING FOSSIL FUEL CENTRAL STATION PLANTS. Ray, J. J. (Philadelphia Electric Co., Pa.).

The choice of site for electric power plants is an important factor in the costs of power generation. There are three determinants in the economic choice of sites: cooling water requirements, transmission requirements, and fuel type and availability. Coordination with neighboring systems, location of plants in coal fields, and pumped storage hydro sites can reduce the costs of power generation. A method for the economic analysis of the factors to establish the criteria for an optimum choice is discussed. (D.L.C.)

**32326** (SWRI-1228-60) FUNDAMENTAL INVESTIGATION OF LIQUID-METAL LUBRICATED JOURNAL BEARINGS. Topical Report. Burton, R. A.; Carper, H. J.; Hsu, Y. C. (Southwest Research Inst., San Antonio, Tex.). Apr. 16, 1965. Contract AT(11-1)-1228. 109p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

A combined experimental and analytical program is reported, with the objective of providing basic design information for liquid-metal lubricated bearings, with emphasis on turbulence and film-inertia effects. The experiments make use of a large-scale bearing model, with 6-foot diameter and 0.5-in. film thickness. The working fluid is air, and Reynolds numbers comparable to those in liquid-metal lubricated bearings may be simulated. Data on velocity profiles, friction coefficients, and turbulence intensity are reported for concentric and eccentric operation, over a broad range of local Reynolds and Taylor numbers. Data are also reported for extremely distorted flows produced by placing a blockage in the film. An analytical approach is reported, which exploits experimentally measured (or theoretically computed) profile parameters to predict pressures in bearing configurations. Data are given which show that inertial effects at the boundaries of the bearing film may at times be of primary importance in bearing calculations. Preliminary measurements of inertial effects at the entry to a tilted pad are reported. (auth)

**32327** (UCRL-11200(Vol. 2)) INDEX OF LRL BERKELEY MECHANICAL ENGINEERING DEPARTMENT ENGINEERING NOTES AND SPECIFICATIONS. VOLUME 2. Turner, James O. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1965. Contract W-7405-eng-48. 186p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

Supersedes Temporary Supplement to Volume 1.

Two indexes are presented of engineering notes and specifications issued up to approx. March 15, 1965. The first index is arranged by number, while the second is a keyword-plus-title index. (D.L.C.)

**32328** GROUND RADIOACTIVE SIGNAL DEVICE AND CONTROL FOR COSMIC RADIATION BACKGROUND. Kovoyashi, A. Genshiryoku Kogyo, 9: No. 10, 8-16(1963). (In Japanese)

The design and development of railroad signals are discussed by which the passage of a train is detected by changes in the distribution of radiation from a source on the roadbed. The use of cosmic radiation as an auxiliary source for the determination of the operating efficiency of the detector is considered in some detail, together with the control (background-count) method that was developed. (D.C.W.)

**32329** CANAL DISCHARGE MEASUREMENTS WITH RADIOISOTOPES. Schuster, Jack C. (Bureau of Reclamation, Denver). J. Hydraulics Div., Am. Soc. Civil Engrs., 91: 101-24(Mar. 1965).

A program is described wherein radioisotopes were used for accurately measuring the flow of water used to generate electricity, irrigate reclaimed land, and for other beneficial purposes. The over-all plan of research includes radioisotope methods of measuring discharges in closed conduits as well as open channels, but the emphasis is on a study of canal discharge measurements made with radioisotopes. The flow way selected for investigating the accuracy and for developing field techniques of the radioisotope method and of discharge measurement was the concrete-lined Yuma-Mesa A Canal, near Yuma, Ariz. Principles of the radioisotope discharge-measuring method are examined. The radioisotope technique of discharge measurement is essentially a dilution method. Portable $\gamma$-ray counting systems were used in the total count method of measuring canal discharges. A system included a battery-powered scaler for counting the electrical pulses received from the detector, and the detector probe was composed of four GM tubes. Fluorescein dye traces were used as an aid in selecting radioisotope injection points and the locations for the counting systems. In making a measurement, the radioisotope (in one test series $^{198}$Au) was introduced into the canal flow by pouring it onto the water surface, or by smashing a glass bottle in an impact device at a selected position. Tests consisting of three phases, each having several radioisotope introductions into the flow, were made in the first test series. In phase 1, four counting systems were located at four different stations along the canal to determine the min mixing length required for full dispersion of the isotope. In phase 2, three counting systems were spaced across the canal perpendicular to the canal centerline, so the extent of lateral mixing at a chosen station was measured. In phase 3, the counting systems were used to investigate the principle of radioisotope measurement in divided streams whereby the total discharge of the main stream is determined by counting and measuring in one of the flowing fractions. Good agreement was obtained between the discharges measured with radioisotopes and those previously measured by current meter rating. In a canal the size of the Yuma-Mesa, flowing at one-half capacity but near design depth, the required length to produce satisfactory mixing of the radioisotope-canal water mixture was about 2500 ft for injections made near the canal centerline. The results showed that with adequate mixing of the radioisotope and canal water, discharge measurement accuracy of 97% or greater is possible when compared to good current meter discharge measurements. A distance of from 2500 to 3000 ft is necessary to produce 98 to 99% mixing in a canal having the hydraulic operating characteristics of the Yuma-Mesa A Canal. For 98 to 99% mixing over a distance of 2500 to 3000 ft in the Yuma-Mesa Canal, the longitudinal diffusion coefficient was about 6.5 ft 2/sec, and the transverse coefficient would be about 0.025 ft 2/sec, or about $\frac{1}{300}$ of the longitudinal diffusion coefficient. Simultaneous multiple injections of tracer provide a higher probability of uniform mixing in shorter lengths than single injections. Higher indicated diffusion coefficients result from multiple simultaneous injections of radioisotopes than from single injections. Despite some difficulties encountered in determining the min mixing length and discharge

measurement accuracy, the measurements showed that, with sufficient data from tests on canals of various sizes, mixing length equations can probably be derived for canals having a min of turbulence. (BBB)

## Applications of Nuclear Explosions

**32330** (AAEC(SP)/R1) PEACEFUL USES OF NUCLEAR EXPLOSIVES—AN EVALUATION, FOR AUSTRALIAN PURPOSES, OF PROPOSED CIVIL ENGINEERING AND MINING APPLICATIONS. Technical Mission to the U.S.A., September–October 1963. Wilson, A. R. W.; Pender, E. B.; Carter, E. K. (Australian Atomic Energy Commission, Coogee). Mar. 1964, Re-printed Feb. 1965. 234p. Dep.(mn); $2.50(cy), 4(mn) CFSTI.

The technology developed within the U.S.A.E.C. Plowshare program for the use of nuclear explosives for engineering and mining purposes is discussed in detail. An explanation of the basic mechanisms involved in contained (deep, non-venting) and cratering (shallow, venting) nuclear detonations is used as the basis for a critical review of the safety aspects and ability to predict the effects of underground nuclear detonations. The effort that would be involved in the mounting and execution of a nuclear engineering explosion is detailed and the various practical and economic considerations affecting the possible application of nuclear explosion techniques to engineering and mining are discussed both broadly and in relation to specific uses. The final summary is an evaluation of the significance of the technique to Australia. It is concluded that, to date, the technology has been defined only in broad outline but, with further development, it could assume a significant, if limited, role in the construction of major works and the exploitation of mineral resources in Australia. (auth)

**32331** (PNE-719P) PRESHOT GEOLOGIC INVESTIGATIONS. Nugent, R. C; Banks, D. C. (Waterways Experiment Station, Vicksburg, Miss.). Mar. 1965. Project SULKY. 92p. Dep.; $3.00(cy), 2(mn) CFSTI.

Results are presented of the preshot geologic and engineering investigations conducted at the Buckboard Mesa site selected for the SULKY event, a nuclear cratering experiment in dry basalt. Geophysical logging and pressure tests were conducted as part of the investigations. (D.L.C.)

**32332** ECONOMIC ASPECTS OF NUCLEAR EXPLOSIVES IN CIVILIAN USES. Energie Nucl., 7: 45-7(Jan.-Feb. 1965). (In French)

A critical summary is made of the Geneva paper P/291 "Engineering applications of Nuclear Explosives Project Plowshare." The requirements for a civilian use of nuclear explosives are analyzed and put into traditional terms. (J.S.R.)

## Facilities and Equipment

*Refer also to abstract 32045.*

**32333** (NYO-3363-1) PRELIMINARY STUDY OF THE LIQUID METAL LOOP AND TEST RIG FOR PHASE II OF THE INVESTIGATION OF LIQUID METAL LUBRICATED BEARINGS AND ROTOR-BEARING DYNAMICS. Waldron, W. D.; Arwas, E. B. (Mechanical Technology Inc., Latham, N. Y.). Feb. 23, 1965. Contract AT(30-1)-3363. 55p. (MTI-64TR72(Rev.2)). Dep.(mn); $3.00(cy), 1(mn) CFSTI.

The results of a study of the mercury loop and the rotor-bearing test rig for use in a liquid metal lubricated bearing and rotor-dynamics program are presented. The modification of the mercury loop for conversion to alkali metal, with NaK selected as the test fluid, is discussed. (L.B.S.)

**32334** (TID-4100(Suppl.28)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Duthie, Richard E. C., ed. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). June 1965. 37p. Dep.; Free(DTI Extension).

Lists are presented under the following headings: hot laboratory equipment and structures, instruments, metallurgical equipment and processes, radiation instruments, reactors and reactor facilities, particle accelerators, plant design and processes, radiation source units, and shielded containers. (D.L.C.)

**32335** IMPROVEMENTS IN PORTABLE ISOTOPE HOLDERS. Molian, Samuel. British Patent 992,866. May 26, 1965. Filed Jan. 24, 1963.

A radioactive isotope pencil includes a generally cylindrical metal body with an axially extending cavity open at one end. The cavity contains a captive spring clip that, when in use, locates a stem attached to a block of radioactive material. The captive spring clip is retained within the cavity by a circumferential groove in its wall. A removable cap may be attached to the end of the metal body adjacent to the open end of the cavity, and an elastic locking and sealing ring is included between the removable cap and the body. After the radioactivity of the block has dropped below a useful level, the block is easily removed from the pencil and replaced with a new block. In use, to reduce the radiation hazard to the operator, the pencil must be handled from a distance using a handling rod that may be attached to the pencil while it is still in a shielding container in which it is normally stored. (B.L.M.)

**32336** IMPROVEMENTS IN OR RELATING TO CUTTING MACHINES. Gerard, Victor; Martin, Jean; Valentin, Andre (to Commissariat a l'Energie Atomique). British Patent 993,439. May 26, 1965. Priority date Mar. 10, 1961, France.

A cutting tool particularly applicable for cutting radioactive fuel elements includes a rotary tool and means for driving the tool at a cutting speed of 1.2 m/sec. The tool is lubricated and cooled by dipping in a liquid bath. During operation the projection of both metallic particles and of the liquid is minimized by the bath: thus reducing contamination risk to a minimum while requiring only a very small quantity of liquid. The cut sample is received in a perforated tray located in the top part of the bath and provided with drain holes. Remote control means may be provided for the operation of the tool and for changing the tool. The remote control mechanism includes comb shaped jaws provided with fingers that interlock so that the device may be adapted to members having different sections. (B.L.M.)

**32337** DEVICE FOR TRANSFERRING RADIOACTIVE ARTICLES. Mansard, Bernard (to Commissariat à l'Energie Atomique). British Patent 993,629. June 2, 1965. Priority date May 8, 1963, France.

A device is provided for transferring radioactive articles between an enclosure having a biological protective screen interrupted at the level of an access door of the enclosure and the outside of the enclosure. The device includes a radiation-absorbing member that is rotatable around its axis adjacent to the enclosure and that is formed with a recess having its axis perpendicular to the axis of rotation. The recess extends through the radiation-absorbing member. A locking mechanism is adapted to retain in the recess a transferring receptacle for the radioactive article. A mechanism is provided to rotate the radiation-absorbing member into a first orientation in which the recess registers with the access door; and into a second orientation in which the recess is parallel with the door, and the radiation-absorbing member has its maximum thickness opposite the door. (B.L.M.)

**32338** IMPROVEMENTS RELATING TO GAMMA-RAY APPARATUS. Fulker, George Robert (to T.E.M. Instruments Ltd.). British Patent 994,327. June 2, 1965. Filed Jan. 2, 1963.

A source head for a gamma-ray apparatus has a source housing that defines a passage having a cross section con-

forming in shape with the maximum required beam cross section for the emergence of the beam. A removable source pencil comprising a source block in a capsule on the end of a shielding plug is adapted to be drawn into the housing, plug first, via the beam exit end of the housing passage. The entire source housing is mounted for rotation, relatively to the head, about the axis of the passage; and a beam collimator is carried by the housing adjacent to the beam exit and rotates with the housing. The collimator is made up of four sets of shielding blades disposed transversely of the beam axis, and the inner edges of the blades define the sides of a rectangle with opposite pairs of blades being movable towards and away from one another to vary the spacing between the inner edges of the blades of the sets. Shutter disc means are provided for obturating the housing passage, and rotation of the disc about its axis positions a diametral passage in the disc in and out of alignment with the housing passage. The shutter disc is rotated by motor driven means, and stops are provided for determining the limit of rotation. (B.L.M.)

**32339** ARRANGEMENT FOR LONG-STANDING STORAGE OF DAMAGED ACTIVE FUEL ELEMENTS OF A NUCLEAR REACTOR. Ericsson, Stig; Nilsson, Bengt; Brunzell, Sven-Otto (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,153,619. Oct. 20, 1964. Priority date Dec. 31, 1959, Sweden.

Damaged irradiated fuel elements are stored in water-filled sealed bottle-shaped storage vessels inserted in a water-filled storage container until radioactivity has decreased to an appropriate extent. An arrangement for inserting a warm element into a bottle includes a revolving disc with openings to carry bottles arranged in at least one, preferably two, circles concentric with the center of rotation of the disc. Bottle covers are mechanically applied and removed. A passage from the reactor to the storage unit is provided with a sealing device to prevent passage of steam. A pump system circulates cooling water through the storage container. (A.G.W.)

**32340** METHOD FOR MANIPULATING RADIOACTIVE MATERIAL. Prest, Robert J. (to Technical Operations, Inc.). U. S. Patent 3,170,065. Feb. 16, 1965. Filed Feb. 8, 1961.

Apparatus and a method for exchanging sources of radioactive material in a radiation exposure device are described. The apparatus includes a shielded container having two separate openings and space for two radiation sources. Suitable connectors and propelling means are provided to permit one source to be moved from the exposure device to a space in the shielded container and a new source, previously stored in the shielded container, to be moved into the exposure device. (A.G.W.)

**32341** X-RAY HOISTING APPARATUS WITH AUTOMATIC SECURING MEANS. Avery, Robert T. (to Varian Associates). U. S. Patent 3,175,085. Mar. 23, 1965. Filed July 13, 1961.

A telescoping boom hoist is designed to transport a high-energy x-ray machine and to support it rigidly and motionlessly in a desired position. A slip drive permits rotation of the machine about a vertical axis without backlash. A track and a spring-loaded follower between sections of the telescoping boom automatically take up the play between sections at all stationary boom positions. (A.G.W.)

**32342** CAESIUM RADIATION UNIT WITH DOUBLE APERTURES. Johns, Harold Elford (to Ontario Cancer Inst.). U. S. Patent 3,175,086. Mar. 23, 1965. Filed Aug. 30, 1960.

A cesium radiation unit, primarily for medical therapy, is designed with shielded storage space for radioactive material and with two exposure windows. A collimator is secured to the unit in alignment with one window, and interchangeable cones are removably secured to the unit in alignment with the other window. The radioactive source may be selectively positioned, one at a time, adjacent to either window or in the storage space. (A.G.W.)

**32343** AUTOMATICALLY ADJUSTABLE POWER SUPPLY FOR X-RAY TUBES. Phelan, William J.; MacPherson, James B. (Weston Instruments, Inc.). U. S. Patent 3,183,357. May 11, 1965. Filed Oct. 22, 1962.

An accurately controlled adjustable power supply for an x-ray tube compensates for undesirable variations in beam intensity that occur when the supply level setting is changed. A source of supply is connected by way of a high voltage transformer to the x-ray tube. A control circuit connected to the source compares its output with that of a selected reference potential level. A feedback to the source is produced to control the magnitude of the high voltage applied to the x-ray tube. A compensation signal that varies as a function of tube current also is applied to the control circuit for further changing the feedback. Thus, the magnitude of the high voltage applied to the tube is varied as a function of changing tube current to compensate for undesirable variations in beam intensity. Compensation is also made for variations in beam intensity resulting from leaking off of excess static charges. (B.L.M.)

## Heat Transfer and Fluid Flow

**See also PHYSICS — General.**

*Refer also to abstracts 33160 and 33529.*

**32344** (ACNP-65001) STEAM SEPARATION TECHNOLOGY UNDER THE EURATOM PROGRAM. Quarterly Progress Report, January 1, 1965–March 31, 1965. (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Atomic Energy Div.). Apr. 9, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1186. 50p. (EURAEC-1376). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Steam dryer testing was completed during the period. Maximum permissible flow rates (the steam flow rate at which moisture carries through the dryer) were determined at 600 to 1800 psi. Results show the permissible flow rate increases from 50,000 lb/hr-ft$^2$ at 1400 psig to 54,000 lb/hr-ft$^2$ at 1800 psig. A 10-in.-dia. upcomer-type separator was installed in the high pressure steam-water loop and testing is in progress. Preliminary tests at 600 and 1000 psi indicate that the separator and the test apparatus are functioning properly. Carryunder was less than 1.5% by volume. Testing of a horizontal separator was continued to provide a better understanding of the centrifugal separator process. High speed photos were taken of the vortex in the separator, with and without air, to accurately determine the separating length. These values were then compared with the calculated separating lengths. Further investigation of separator inlets and outlets was continued. (J.R.D.)

**32345** (AEEW-R-363) AN EXPERIMENTAL INVESTIGATION TO DETERMINE THE SCALING LAWS OF FORCED CONVECTION BOILING HEAT TRANSFER. PART I. THE PRELIMINARY EXAMINATION USING BURNOUT DATA FOR WATER AND ARCTON 12. Barnett, P. G. (Atomic Energy Establishment, Winfrith (England)). June 1964. 47p. Dep.(mn).

Five possible sets of scaling laws for forced convection boiling heat transfer are tested using burnout data for water and Arcton 12 in uniformly heated round tubes. One of these sets is found to link the data to ±6%, but there are indications that at least one more property must be included in order to obtain an accurate model. (auth)

**32346** (CONF-640507) PROCEEDINGS OF THE SECOND JOINT USAEC-EURATOM TWO-PHASE FLOW MEETING HELD AT USAEC, GERMANTOWN, MARYLAND, APRIL 29, 30, AND MAY 1, 1964. Scroggins, Ronald M. (ed.) (Division of Reactor Development (AEC), Washington, D. C. Engineering Development Branch). Nov. 1964. 546p. Dep.(mn); $5.50(cy), 9(mn) CFSTI.

A total of 42 papers are arranged under the following headings: introduction, two-phase heat transfer (water),

two-phase heat transfer (liquid metal), methods to increase two-phase heat transfer, two-phase hydraulic and boiling stability, and two-phase fluid dynamics. Separate abstracts were prepared for 37 of the papers; for abstracts of the 5 remaining papers, see NSA 18: 27652, 31724, 33737, 35686, and 19: 580. (D.L.C.)

*For abstracts of individual papers see: 32347, 32348, 32349, 32350, 32351, 32352, 32353, 32354, 32355, 32356, 32357, 32358, 32359, 32360, 32361, 32362, 32363, 32364, 32365, 32366, 32367, 32368, 32369, 32370, 32371, 32372, 32373, 32374, 32375, 32376, 32377, 32378, 32379, 32380, 32381, 33591, and 33592.*

**32347** (CONF-640507(p.3-7)) JOINT TWO-PHASE FLOW PROGRAM. Scroggins, R. M. (Division of Reactor Development and Technology (AEC), Washington, D. C.).

The history and objectives of the Joint USAEC–EURATOM Two-phase Flow Program are outlined. Some of the outstanding problem areas and questions are discussed in the fields of two-phase heat transfer and methods of increasing it, boiling instabilities, fluid dynamics, pressure drop, and subcooled boiling. (D.L.C.)

**32348** (CONF-640507(p.9-11)) PRESENTATION OF THE EURATOM PROGRAM. Morin, Rene (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The objectives of the Euratom program on two-phase flow are research on boiling water heat transfer and development of boiling water reactors. The contracts which were carried out in the program are outlined, and some programs which are now under way are also described. (D.L.C.)

**32349** (CONF-640507(p.15-16)) FUNDAMENTAL STUDIES IN BOILING. Morin, Rene (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

Conclusions are presented from a Schlieren study of bubble generation and its effects on temperature distribution, using a horizontal heated rod in 60°C water. The width of the boundary layer and the transport of hot liquid packets by bubbles were studied. Conclusions are also presented from a study of wall temperature fluctuations during bubble nucleation; they indicate that the fluctuations are produced by vaporization of a thin liquid layer at the bubble base. (D.L.C.)

**32350** (CONF-640507(p.17-18)) VISUALISATION OF SATURATED AND SUBCOOLED POOL BOILING BY SCHLIEREN-PHOTOGRAPHY. Villeneuve, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

Schlieren black/white and color films were shown for four different cases ranging from saturation temperature to 70°C subcooling and from 5 to 50 w/cm$^2$. The behavior of bubbles in each case is discussed. (D.L.C.)

**32351** (CONF-640507(p.19-32)) INVESTIGATIONS INTO THE CRITICAL HEAT FLUX (BURN-OUT) IN BOILING. Mayinger, F. (Maschinenfabrik Augsburg-Nuernberg A. G., Nuremberg (West Germany)).

A research program is being conducted on the influence of inlet flow conditions on the critical heat flux in tubes. The boiling water test rig and instrumentation are described, and the present status of the work is outlined. The theoretical work includes the preparation of equations for predicting void fractions. (D.L.C.)

**32352** (CONF-640507(p.33-6)) INVESTIGATION OF TWO-PHASE FLOW AND BURNOUT. Suo, M. (Dynatech Corp., Cambridge, Mass.).

A research program is being conducted on flow regimes in forced-convection burnout in heated tubes. The equipment is described, and the experimental program is outlined. (D.L.C.)

**32353** (CONF-640507(p.37-44)) NON-UNIFORM HEAT GENERATION EXPERIMENTAL PROGRAM. Swenson, H. S. (Babcock and Wilcox Co., Alliance, Ohio. Research Center).

The influence of non-uniform heat flux distribution on burnout is discussed. Experiments will be made with uniform distributions (chopped cosine, inlet peak, and outlet peak). The test section and loop are described. (D.L.C.)

**32354** (CONF-640507(p.45-62)) OBSERVATIONS IN CORRELATING BURNOUT DATA. Wilson, R. H. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.).

Results are presented of analysis of burnout data from uniformly and non-uniformly heated channels for water systems. It is concluded that burnout data have been correlated for uniform fluxes, but for non-uniform fluxes, the burnout location and flux are dependent variables. (D.L.C.)

**32355** (CONF-640507(p.63)) FILM BOILING HEAT TRANSFER AT LOW QUALITY OR SUBCOOLED REGION. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

The flow patterns of film boiling at low and high qualities are discussed briefly. The engineering correlation used for the film boiling heat transfer at low quality or subcooled region is $H\,De/k_w = 0.005(De\ Vm\ w/\mu_w)(c_p\mu/k)_w^{0.5}$. (D.L.C.)

**32356** (CONF-640507(p.65-72)) HOW TO PRESENT BURNOUT (OR DNB) DATA. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

It is shown that critical heat flux graphs are misleading unless the other parameters are listed. All the independent parameters, including weak parameters, should be included in the boiling crisis data presentations. (D.L.C.)

**32357** (CONF-640507(p.73-7)) BOILING BURNOUT WITH 19-ROD BUNDLES. Batch, J. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Boiling burnout experiments were carried out on heated models of a 19-rod bundle fuel element with a heated length of 19.5 inches. Some of the conclusions made from the experiments are: an inverse mass flow effect exists at high qualities, the flow inverter has little effect when the inlet coolant is wet steam, the length of the unheated upstream section and the spacers have little effect, and a discontinuity exists in the relation between burnout flux and exit enthalpy at $5 \times 10^5$ lb/hr-ft$^2$. The behavior of rod wall temperature at heat fluxes beyond the start of burnout was studied. (D.L.C.)

**32358** (CONF-640507(p.79-87)) SOME RECENT DEVELOPMENTS OF THE STUDIES ON HEAT TRANSFER AND HYDRODYNAMICS IN TWO-PHASE FLOW UNDER WAY AT CISE. Peterlongo, G. (Centro Informazioni Studi Esperienze, Milan (Italy)).

A summary is presented of part of the work performed in the CAN-2 and CAN-3 programs on heat transfer and hydrodynamics with steam–water mixtures in two-phase flow. The work is discussed under the following headings: pressure drop in round tubes with vertical upflow, heat transfer, heat transfer crisis, and heat transfer crisis in complex geometries (annuli and clusters). (D.L.C.)

**32359** (CONF-640507(p.89-106)) HEAT TRANSFER AND HYDRODYNAMICS RESEARCH COMPACT POWER PROGRAM. Bernath, L.; Cohn, P. D. (Atomics International, Canoga Park, Calif.).

A program is underway to verify the thermal and hydraulic performance of compact boiling reactor core designs. The thermal conditions are discussed, and the analytical part of the program is described. (D.L.C.)

**32360** (CONF-640507(p.107-22)) INVESTIGATION OF TRANSITION BOILING HEAT TRANSFER AT GENERAL ELECTRIC COMPANY. Quinn, E. P.; Hench, J. E.; Swan, C. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.).

Measurements of boiling water heat transfer beyond the critical heat flux were obtained for steam qualities >25% for high-pressure forced flows for a two-rod cluster and

a single rod in an annulus. High speed motion pictures were also made of the flow patterns for the single rod. Preliminary tests were made of the heat transfer performance of small circumferential fins on the heated tube. (D.L.C.)

**32361** (CONF-640507(p.125-37)) THE BOILING LIQUID METAL PROGRAM AT ARGONNE NATIONAL LABORATORY. Brubaker, R. C.; Heineman, J. B.; Holtz, R. E.; Stein, R. P. (Argonne National Lab., Ill.).

The boiling liquid metal program is divided into two separate experimental efforts on sodium pumped around heated flow pumps: pressure and vapor volume fraction measurements in unheated test sections at boiling temperatures below 1600°F, and measurements in heated test sections at boiling temperatures up to 2100°F. The 1600 and 2100°F loops are described. Methods for heating test sections at high heat fluxes in the second loop are discussed. (D.L.C.)

**32362** (CONF-640507(p.153-71)) HEAT TRANSFER DURING FILM CONDENSATION OF A LIQUID METAL VAPOR. Rohsenow, W. M. (Massachusetts Inst. of Tech., Cambridge).

The discrepancy between theory and experiment in heat transfer during film condensation of liquid metal vapors is discussed. Possible modes of additional thermal resistance between the condensing vapor and the condenser wall are analyzed, and it is shown that, in the absence of non-condensable gases, such a resistance can only exist at the liquid-vapor interface. An experimental investigation on mercury vapor was conducted in which condensate film thickness and condensing side heat transfer coefficient were measured, and the effects of solid-liquid interface and non-condensable gases were studied. (D.L.C.)

**32363** (CONF-640507(p.173-94)) HEAT TRANSFER AND PRESSURE DROP FOR FORCED CONVECTION BOILING OF RUBIDIUM AND CESIUM. Fisher, C. R. (Aerojet-General Nucleonics, San Ramon, Calif.).

Results are presented of an experimental investigation of the heat transfer and pressure drop characteristics of boiling rubidium and cesium in forced convection. Nucleate boiling heat transfer data were obtained and are plotted in the form of heat flux versus temperature difference. Critical heat flux data are compared to a simple fog flow model. Two-phase pressure drop results are compared to a modified homogeneous flow model of Kutateladze and also to a correlation of Schrock and Grossman. (auth)

**32364** (CONF-640507(p.213-16)) THE VAPOTRON. Beurtheuret, C. (Compagnie Francaise Thomson-Houston, Paris).

The Vapotron is a device for suppressing the critical point of the Nukiyama curve and for shifting the boiling crisis to high flux densities. Its effect is due to the cross stabilization of transition boiling and to a continuous temperature gradient along an extended heat transfer area. It is shown that the Vapotron concept, proven for copper, can be extended to low conductive materials. The test program and section are described. The effects of high temperature gradients are discussed. The causes for the high resistance to burnout are outlined. (D.L.C.)

**32365** (CONF-640507(p.217-52)) STUDIES OF BOILING HEAT TRANSFER WITH ELECTRICAL FIELDS. Markels, Michael Jr.; Durfee, Robert L. (Atlantic Research Corp., Alexandria, Va.).

Alternating current voltage (60 cps) was found to increase boiling heat transfer rates and prevent film boiling for deionized water under forced convection at essentially ambient pressure. Steam was used to supply heat to the interior wall of an annulus, and voltages up to 5,000 volts were impressed across the region of vapor formation. The highest heat transfer rates reached were approximately twice the normal nucleate boiling peak. No effects of mass flow rate up to $5.2 \times 10^5$ lb/hr-ft$^2$ or of exit quality up to about four per cent by weight vapor on the heat transfer increased by voltage application were observed. Data obtained from tests in which the external wall of the flow annulus was heated indicated an increase in heat flux up to 2,000 volts, followed by a decrease in heat flux at voltages above 2,000 volts. An analysis of surface wetting during voltage application for isopropanol and water was made using current and voltage measurements from previous work. In the normal film boiling region of ($T_{steam} - T_{sat}$), surface wetting initially contributes strongly to the increased heat transfer and, at higher voltages, other factors such as local mixing and bubble characteristics appear to predominate. Based on this model, it was shown that the ratio of the sum of electrostatic forces for heating internally and heating externally (3.46 to 1) was close to the ratio of heat transfer increases per unit voltage for heating internally and heating externally (4.3 to 1) for a bubble radius of 0.05 inch. (auth)

**32366** (CONF-640507(p.273-9)) ADAPTATION OF SWIRL FLOW TO BWR. Moussez, Claude (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France)).

Hydrodynamic and thermal tests were made in a four-rod test section in a channel with and without tapes. The pressure drop and critical heat flux results are discussed; it is seen that tapes and roughness increase the critical heat flux at all mass flows. (D.L.C.)

**32367** (CONF-640507(p.281-96)) REVIEW OF THE GEOSCIENCE BOILING LIQUID-METALS RESEARCH PROGRAM. Poppendiek, H. F. (Geoscience Ltd., [Solana Beach, Calif.]).

The effects of helical flow on heat transfer and fluid flow in forced-flow boiling mercury were studied. Some models of droplet vaporization at a boiler tube wall, fog flow, and single-phase (superheat) flow are discussed. Measurements on mercury with linear and helical flow are compared with linear flow theory. (D.L.C.)

**32368** (CONF-640507(p.299-309)) STUDY ON FLOW OSCILLATION IN A BOILING CHANNEL. Villeneuve, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

Experimental results on instability thresholds on specific power vs subcooling graphs are discussed briefly. Theoretical studies of flow oscillations are under way; three models (time lag, density, and friction) are being developed, and the first two are discussed in detail. (D.L.C.)

**32369** (CONF-640507(p.337-64)) A PROGRAM OF TWO-PHASE FLOW INVESTIGATION WITH HEAT ADDITION. Staub, F. W.; Zuber, N. (General Electric Co., Schenectady, N. Y. Advanced Technology Labs.).

Experimental and analytical programs are being conducted to study thermal-hydraulic oscillations in forced-convection two-phase flow systems with heat addition. The experimental program will use Freon-22, while the analytical program will obtain equations and criteria for predicting the inceptions of the oscillations. The test loops, test sections, instrumentation, and results of shakedown tests are described. An outline is presented of the analytical program. (D.L.C.)

**32370** (CONF-640507(p.367-85)) FOG FLOW MODELS. Stein, Ralph P. (Argonne National Lab., Ill.).

A brief description is given of the fog flow model which was developed in the CAN-2 program. The extensions of the model (Negligible Liquid Film Model and Stable Liquid Film Model) are discussed. The application of these models to round tubes is considered. (D.L.C.)

**32371** (CONF-640507(p.387-9)) THEORETICAL PRESSURE AND PHASE DISTRIBUTIONS IN TWO-PHASE FLOW. Bradfute, J. O. (Aerojet-General Corp., Azusa, Calif.).

Six basic equations are given which will be used to predict the longitudinal distributic ı of pressure, temperature, quality, and void fraction in a heated channel. (D.L.C.)

**32372** (CONF-640507(p.391-2)) AN ABSTRACT OF CURRENT WORK IN TWO-PHASE FLOW AT M. I. T.

Griffith, P.; Haberstroh, R.; Rose, S. (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering).

An electrical conductivity probe was used to detect bridges of liquid across the center of the pipe, which are taken to indicate slug flow. Some of the flow properties of bubbly mixtures are discussed briefly. (D.L.C.)

**32373** (CONF-640507(p.393-406)) TWO-PHASE FLOW RESEARCH AT DARTMOUTH COLLEGE. Wallis, G. B. (Thayer School of Engineering, Dartmouth Coll., Hanover, N. H.).

Studies of the annular flow regime and its breakdown into other flow regimes are described. Droplet entrainment in the annular regime was measured for air–water and air–silicone mixtures. Void fraction measurements are reported for upward cocurrent annular flow of air–water. Finally, the determination of flow regime boundaries was attempted. (D.L.C.)

**32374** (CONF-640507(p.407-39)) BUILDING 11 — TWO-PHASE FLOW PROGRAM. Petrick, M. (Argonne National Lab., Ill.).

Research is being conducted on a wide variety of two-phase flow problem areas. Some of these projects include: two-phase flow parameters during the complete vaporization of a fluid, inception of instability in a boiling loop, power-to-void transfer functions, propagation of void waves in an air–water system, instability in a loop near the thermodynamic critical point, critical flow, and a fluoroscope for studying two-phase flow patterns in high pressure systems. (D.L.C.)

**32375** (CONF-640507(p.441-58)) PROGRESS IN VAPOR VOLUME FRACTION PROGRAM. Neusen, K. F. (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Atomic Energy Div.).

Vapor volume fraction measurements are being carried out in a large unheated duct over a wide range of flow conditions, with emphasis on low liquid flow velocities. A description is given of the heat transfer loop and the gamma attenuation instrumentation. Graphs of some of the void fraction results are included and discussed. (D.L.C.)

**32376** (CONF-640507(p.459-78)) TWO-PHASE PRESSURE DROP. Janssen, E.; Kervinen, J. A.; Levy, S. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.).

The investigation of two-phase pressure drop was divided into three tasks: (1) adiabatic flow of high-pressure (600 to 1400 psia) steam–water mixtures past contraction and expansion geometries, (2) flow in straight rectangular and circular channels, (3) flow in straight channel with heat addition. Some of the work completed since the last report is described. (D.L.C.)

**32377** (CONF-640507(p.479-81)) CRITICAL FLOW OF STEAM-WATER MIXTURES THROUGH SHORT PIPES. Batch, J. M. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

When a two-phase mixture entered the test section, choking occurred at the exit of the test section, and the results agreed well with the predictions of the Fauske critical flow theory. On the other hand, when compressed water was made to flash to a steam–water mixture in the pipe, the choking was mainly located at the entrance of the test section. A correlation was found between the upstream pressure and the velocity in the upstream choking. (D.L.C.)

**32378** (CONF-640507(p.483-7)) TWO-PHASE PRESSURE DROP IN PIPING COMPONENTS. Batch, J. M. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Pressure losses from the flow of liquid and steam–water mixtures were determined for straight 2-in. pipe and various piping components. The two-phase to single-phase pressure-drop ratios for the straight pipe were correlated well by the Levy model. The data for the bends agreed well with literature values. For the expansions and contractions, the pressure-drop ratios agreed with these predicted from a homogeneous model. Pressure drops through the gate and globe values are discussed. (D.L.C.)

**32379** (CONF-640507(p.489-97)) VOID FRACTION MODELS IN SUBCOOLED BOILING. Villeneuve, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

The problem of deriving a simple formula for the void fraction $\alpha$ and quality X is considered for subcooled boiling in a uniformly heated channel. The two models of Lavigne and Fabre are described. It is shown that these models give a good approximation of experimental results for high pressures, and that pressure drop data can be correlated without any discontinuity in the friction factor at zero thermodynamic quality. (D.L.C.)

**32380** (CONF-640507(p.499-506)) A STUDY OF CONVECTION BOILING INSIDE CHANNELS. Ferrell, J. K. (North Carolina State of the Univ. of North Carolina, Raleigh).

Studies are being conducted on two-phase frictional pressure losses in the boiling of water in uniformly heated channels. The procedure for obtaining the pressure losses from experimental data is outlined. Plots of the acceleration factor, average density, pressure, and pressure losses versus quality are included. (D.L.C.)

**32381** (CONF-640507(p.529-31)) RESEARCH EFFORTS ON BOILING AND TWO-PHASE FLOW IN THE CRYOGENIC HEAT TRANSFER SECTION OF NASA LEWIS RESEARCH CENTER. Hsu, Y. Y.; Graham, R. W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

Brief descriptions are given of projects in the following areas: mechanism of boiling heat transfer, mechanism of two-phase flow, heat transfer to hydrogen in sub-critical and super-critical states, and effects of body forces on boiling and two-phase flow. (D.L.C.)

**32382** (EUR-2409.d) AUSWERTUNG VON RECHNUNGEN ZUM PROBLEM DER WARMELEITUNG DURCH STRAHLUNG IN FESTKORPERN. (Evaluation of Calculations on the Problem of Heat Transfer by Radiation in Solids). Richter, J.; Schmidt, H. E. (European Atomic Energy Community, Karlsruhe (West Germany). Transuranium Inst.). Apr. 1965. 25p. Dep.(mn).

The temperature profile across a slab in the case of interacting phonon conduction and radiative heat transfer is described by an integro-differential equation. Numerical solutions of this equation are described. In several cases of practical interest an "effective thermal conductivity" is calculated and its dependence on temperature and specimen thickness are shown. One finds that under conditions which normally persist in high temperature diffusivity experiments, the influence of radiative conduction is negligible in monocrystalline $UO_2$-platelets which are less than 1 mm thick. The contribution of radiation increases however rather rapidly with increasing thickness. The measured thermal conductivity thus depends in "thick" samples strongly on the specimen dimensions. This could help to explain why in some cases different authors found inconsistent results in high temperature thermal conductivity measurements on comparable materials. (auth)

**32383** (EUR-2432.d) MESSUNG DER KRITISCHEN WARMESTROMDICHTE VON WASSER IM UNTERKUHLTEN ZUSTAND IN ROHREN BEI ERZWUNGENER STROMUNG. (Measurement of the Critical Heat-Flux-Density of Subcooled Water in Tubes at Forced Flow). Burck, E.; Hufschmidt, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 1965. 36p. Dep.(mn).

The critical heat-flux-density (burnout) of subcooled water in a stainless steel tube of 10 mm ID and a length of 350 mm has been investigated in the following ranges: wall thickness of tube: $0.5 \leq \delta \leq 1$ mm, outlet pressure: $10 \leq P_0 \leq 30$ bar, outlet subcooling: $0 \leq (T_s - T_0) \leq 100°C$, and mass-flow-density of the water: $960 \leq q_m \leq 3300$ kg/m$^2$

sec. The critical heat-flux-density increased with increasing pressure, subcooling, and mass-flow-density. A variation of the wall-thickness of the tube in the tested range had no influence on burnout. (auth)

**32384** (KAPL-M-6453) COMPACT HEAT EXCHANGER TEST. McDermott, M. A. (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 10, 1965. Contract W-31-109-eng-52. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Friction factors and heat transfer coefficients were determined for the flow of air over banks of closely spaced tubes. The ratio of the minimum flow opening to the tube diameter (gap/diameter ratio) was varied from 0.2 to 0.4. Separate tests were conducted to obtain results for flow between rows of tubes and for flow between a row of tubes and a wall. Reynolds numbers were varied from $10^4$ to $10^5$. The heat transfer results were in good agreement with the results of other investigators at larger gap/diameter ratios. The friction factors were smaller for the small gap/diameter ratios than for larger ratios. (auth)

**32385** (KAPL-M-6459) TUBE—STRESS ANALYSIS OF U-TUBE TYPE HEAT EXCHANGERS. Spivak, A. E.; Lechliter, G. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 3, 1965. Contract W-31-109-eng-52. 73p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The computer program TUBE solves for the stresses due to pressure and temperature in a U-tube type heat exchanger. Specifically, it handles a configuration consisting of a spherical head, primary transition cylinder, perforated tubesheet with a solid outer ring, secondary transition cylinder, and secondary cylinder. The transition cylinders may be conical and tapered in thickness but the remaining shells are of uniform thickness. The spherical head and the transition cylinders may be omitted from a problem. TUBE performs an interaction analysis based on structural mismatches, due to pressure and temperature, using the usual method of matching rotations and deflections at the junctions of the structural elements. Average temperatures are used in the head and tubesheet for this portion of the analysis so that the resulting stresses are axisymmetric. The only non-axisymmetric stresses calculated are for the tubesheet. These are the divider lane stress originating from the difference in temperature between the inlet and outlet halves of the tubesheet, and the skin stress due to the temperature profile through the thickness of the tubesheet. Primary pressure stresses are calculated by means of Lamé's thick shell equations. The average running time on the Philco 2000 computer is approximately 20 seconds per case. (auth)

**32386** (NP-15023) COLLAPSE OF A CAVITATION BUBBLE IN VISCOUS, COMPRESSIBLE LIQUID—NUMERICAL AND EXPERIMENTAL ANALYSES (thesis). Technical Report No. 15. Ivany, Richard David (Michigan Univ., Ann Arbor. Lab. for Fluid Flow and Heat Transport Phenomena). Apr. 1965. 218p.

A study was made of the behavior of the interface and the liquid adjacent to the interface, after the bubble is formed and starts to collapse in a cavitating venturi. The theoretical and experimental bubble radius vs time curves were compared. Viscosity, surface tension, and compressibility effects are discussed, and possible damage mechanisms are considered. (D.L.C.)

**32387** (NP-15051) GAS BUBBLE ENTRAINMENT IN WATER AND MERCURY VERSUS GAS CONTENT. Internal Report No. 6. Robinson, M. J.; Hammitt, F. G. (Michigan Univ., Ann Arbor. Lab. for Fluid Flow and Heat Transport Phenomena). Jan. 1965. 33p.

An experiment is described involving photographs of flow of water and mercury with entrained gas to obtain data on visible bubble sizes and visible gas content for known loop operating parameters and known total gas content. From a comparison of the estimated visible gas content and the known total gas content, conclusions are drawn regarding the distribution between dissolved and entrained gas. Conclusions are also presented regarding smallest visible bubble sizes, average mean observed sizes in both fluids, and homogeneity of the gas distribution in the fluids. (auth)

**32388** THEORETICAL CALCULATION OF HEAT TRANSFER AND FRICTIONAL RESISTANCE FOR TURBULENT FLOW IN A TUBE OF EQUILIBRIUM DISSOCIATING HYDROGEN (T). Petukhov, B. S.; Popov, V. N. (Moscow Power Inst.). High Temp. (USSR) (English Transl.), 2: 541-52(July-Aug. 1964). Translated from Tepolfiz. Vysokikh Temp., 2: 599-611(July-Aug. 1964).

The frictional resistance and heat transfer in turbulent flow of dissociating equilibrium hydrogen in a tube were calculated for a point well removed from the entrance over the temperature range from 2000 to 5000°K. Three values of pressure (1, 10, and 100 atm) were used. (D.C.W.)

**32389** EFFECT OF A LONGITUDINAL MAGNETIC FIELD ON CONVECTIVE HEAT TRANSFER FOR TURBULENT FLOW OF A CONDUCTING FLUID IN A TUBE. Krasilnikov, E. Yu. High Temp. (USSR) (English Transl.), 2: 553-6(July-Aug. 1964). Translated from Tepolfiz. Vysokikh Temp., 2: 612-15(July-Aug. 1964).

A method is proposed for calculating the convective heat transfer for the steady turbulent flow of an incompressible conducting fluid in a smooth circular tube in a longitudinal magnetic field. The method of calculating convective heat exchange in media with $Pr \ll 1$ proposed by Levich and the expression for the velicity profile in an MHD boundary layer with a longitudinal magnetic field proposed by Napolitano are used. (auth)

**32390** FURTHER HYDRAULIC AND HEAT TRANSFER MEASUREMENTS IN AN ANNULUS WITH ROUGHENED INNER TUBE. Grunwald, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 8: 215-18(Apr. 1965). (In German)

Hydraulic and heat transfer measurements in an annulus with heated inner tube roughened by grooves were carried out in turbulent flow using a water coolant. The results obtained in this case have a direct relationship to those determined previously, which had been carried out by using an inner tube roughened by wires of different diameters and pitches. The results of the heat transfer studies may be interpreted by the same dependence of the corrected Nusselt number on the coolant shear strain on the wall, Reynolds number, and height of the roughness. (auth)

**32391** HEAT TRANSFER AND PRESSURE DROP FOR CROSS FLOW THROUGH BANKS OF MULTISTART HELICAL TUBES WITH UNIFORM INCLINATIONS AND UNIFORM LONGITUDINAL PITCHES. Gilli, P. V. (Waagner-Biro AG, Vienna). Nucl. Sci. Eng., 22: 298-314(July 1965).

Heat transfer and pressure drop characteristics for the flow across banks consisting of plain (unfinned) helical tubes in a multistart arrangement with essentially uniform inclination angles, uniform longitudinal pitches, and, hence, essentially equal heat loads per tube, but with tube pattern changing continuously around the perimeter, are reduced analytically to the relatively well-known heat transfer coefficients and friction factors for the flow across banks of straight tubes with in-line and regularly staggered tube patterns. For this purpose, correction factors for the effects of tube inclination and of the number of tube rows are introduced. The effective average values of the free flow area—which determine the effective velocity and hence the effective Reynolds number—and the effective arrangement factors are obtained by integration of the local values. The apparent differences of the heat transfer and pressure drop correlations obtained by the two experimental investigations known—the Waagner-Biro experiments on the prototype tube bundle of the steam generators for the OECD High Temperature Reactor Project Dragon and the data of Glaser on regenerator inserts—are explained quantitatively by the different approach employed for calculating the free flow area. Using the expressions for the effective average free flow area and the correction factors for tube inclination and tube row numbers, agreement of the heat transfer and pressure drop data of both experimental investigations with

each other and with straight-tube data is achieved. The suggested heat transfer and pressure drop correlations for banks of helical tubes are valid for gases and liquids with Prandtl numbers above 0.1. This range includes applications to steam generators of gas-cooled and liquid-cooled reactors (and cryogenic applications as well). For heat exchangers and steam generators of liquid-metal-cooled reactors—that is for Prandtl numbers of the order of 0.01—a different heat transfer correlation is developed, which is based on available data obtained with liquid metal flowing across banks of straight tubes. (auth)

**32392** CONSIDERATIONS OF THE LAW OF GROWTH OF THE BUBBLE. Cumo, M.; Pinchera, G. C. Riv. Ing. Nucl., 2: 635-40(Nov.-Dec. 1965). (In Italian)

A model evaluating the double mechanism of thermal exchange by evaporation and by condensation occurring in a bubble growing on a boiling surface is proposed for integration and correction to the present model of nucleate boiling. The theory is compared with experimental results. (J.S.R.)

**32393** THE MAXIMUM HEAT EXCHANGE LEVELS IN LIQUID METAL BOILING. Labuntsov, D. A.; Shevchuk, E. N.; Pazyuk, P. A. (Krizhizhanovskii Inst. of Power Engineering, USSR). Teplofiz. Vysokikh Temp., 3: 276-84(Mar.-Apr. 1965). (In Russian)

Two models of processes, corresponding to the boiling of metals with different surface conditions, were examined. It was shown that when the general conditions of activation of the centers of steam generation for metals and the common liquids are identical (model 1), the thermal exchange of the boiling metals has high intensity. The steam generating processes on the heating surfaces were hampered to the extent of the pressure decreases. The analysis of the boiling of metals for the most difficult conditions of steam generation (model 2) made it possible to evaluate the minimum conditions of heat exchange. The existing experimental data are evaluated on the basis of these two models. (tr-auth)

## Materials Testing

*Refer also to abstract 32753.*

**32394** (EURAEC-1341) NON-DESTRUCTIVE WELDING. Quarterly Report No. 12. (Roentgen Technische Dienst N. V., Rotterdam (Netherlands)). Mar. 31, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 045-61-5 RDH. 26p. (EUR-2317). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Factors influencing the image quality of radiographs and means for evaluation of it are reviewed. The use of a microdensitometer for an objective evaluation is considered and results of preliminary investigations given. The correlation between visual evaluation of the image quality and measurements is envisaged. The results of previous ultrasonic investigations were analyzed in detail and supplementary tests on the test-piece 300 A-B were made. A double probe technique was applied whereby the probes were placed in tandem. With this technique, defects were revealed that were missed with the single probe technique. The double probe technique appears to be more sensitive to two dimensional defects lying nearly perpendicular to the plate surface and gives better information on defect size. (auth)

**32395** RADIOGRAPHY USING Co-60 AND Cs-137. Furuta, Junichiro; Hiraoka, Eiichi (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 76-7(Mar. 1965).

The nondestructive inspection of aluminum alloy is becoming necessary in the industrial field. The radiographic fault sensitivity and the exposure charts of aluminum in response to these inspections were studied. The effective thickness of aluminum was in the region of 20 ~ 160 mm and that of steel was 20 ~ 100 mm using Cs-137. (auth)

**32396** CLASSIFICATION METHOD AND APPARATUS. (to Nuclear Materials and Equipment Corp.). British Patent 992,811. May 19, 1965. Priority date Mar. 14, 1961, United States.

Computer apparatus is provided for use in processing neutronic pellets by determining density deviation of an object from its weight and volume deviation. The apparatus includes object-volume measuring means and object-weight measuring means to which each object under observation is subjected. A conveyor belt subjects the objects to these measuring means that determine the deviation of the weight and volume of the process articles from standard objects. Computer means compute the density deviation from the weight and volume deviations of each subjected article. The apparatus includes means for rejecting objects whose density deviation is outside preset limits. (B.L.M.)

**32397** CONTINUOUS OBJECT PROCESSING APPARATUS. (to Nuclear Materials and Equipment Corp.). British Patent 992,812. May 19, 1965. Priority date Mar. 14, 1961, United States.

An apparatus is provided for the automatic processing of a large number of objects such as reactor fuel pellets. A scale for precisely weighing each object includes a balancing beam and means connected to the beam for receiving an object to be weighed. The scale also includes a bearing for centrally suspending the beam to be balanced during the weighing operation, and the bearing includes a tensioned torsion member. The beam is pivotally suspended on the member transversely to the member, and the weighing is effected by torsioning the member over a small angle dependent on the weight of the object being weighed. The measuring apparatus includes a linear variable differential transformer. A gaging unit measures the diameter and length of the objects and automatically computes the volume. If the ejector unit receives no information of exceeded limits for length, diameter, or density deviations, it ejects the pellets into an accepted channel; however, if the eject unit receives information that any of the measured quantities exceed preset limits, it ejects the pellet into a reject channel. The sequencing of the mechanisms that move the pellets through the gaging unit, and the weighing unit and that operate the ejector unit at the proper time is controlled by a computer program unit. (B.L.M.)

**32398** SHUTTER CONTROLLED RADIOGRAPHIC EXPOSURE UNIT. Green, Farno L. (to General Motors Corp.). U. S. Patent 3,177,364. Apr. 6, 1965. Filed Aug. 22, 1962.

A storage and exposure unit for use with low-energy radiation sources includes a hollow mass of shielding material having an exposure aperture. A rotary source-carrying member within the shield permits alignment of the source with the exposure aperture. A rotary shutter member has a second exposure aperture that may be aligned with the first exposure aperture. A control mechanism is provided to actuate the source-carrying member and shutter member according to a predetermined schedule. (A.G.W.)

## Protective Structures

**32399** (PSDC-TR-14) DESCRIPTION, EXPERIMENTAL CALIBRATION, AND ANALYSIS OF THE RADIATION TEST FACILITY AT THE PROTECTIVE STRUCTURES DEVELOPMENT CENTER. McDonnell, C.; Velletri, J.; Starbird, A. W.; Batter, J. F. (Conesco, Cambridge, Mass.). Sept. 1, 1964. Contract DA-18-020-eng-3096. 98p. (AD-607127). $4.00(CFSTI)

The initial calibration experiments performed at the Radiation Test Facility of the Protective Structures Development Center are described and their results analyzed. The dose rate above an open field and the attenuation afforded by the steel frame of the test structure are calculated and found to agree well with experiment when modified calculational procedures are used. The cumulative

angular distribution of direct radiation is found to be as much as fourteen percent above that predicted by theory over the range investigated. Several modifications of presently used calculational techniques are suggested. (auth)

**32400** COMPUTER PLOTS POTENTIAL NUCLEAR DAMAGE. Joel, Mai Liis; Lottridge, Douglas D. Natl. Bur. Std. (U. S.), Tech. News Bull., 49: 85-6(June 1965).

Use of a computer program for determining the lethal radii of overpressures from nuclear explosions around a prime target is discussed. The results of computations are encoded on magnetic tape, which drives a plotter to produce overlays. These overlays, when superimposed on standard maps, show the hardness required of installations to withstand hypothetical nuclear attacks. Corrections for off-target blasts are provided. (M.C.G.)

## Space Propulsion

**See also REACTOR TECHNOLOGY — Propulsion and Space.**

*Refer also to abstract 33400.*

**32401** (65SD4296) NAVIGATOR STUDY OF ELECTRIC PROPULSION FOR UNMANNED SCIENTIFIC MISSIONS. VOLUME 1. MISSION ANALYSIS. Brown, H; Taylor, J. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Mar. 1, 1965. Contract NAS3-2533. 128p. (NASA-CR-54324(Vol.I))

Mission analyses are described, and the vehicle power-plant requirements are presented in terms of trip time, power level, and payload for optimum orbiter and fly-by missions as accomplished by electrically propelled spacecraft. The payload and trip time capabilities for chemical and chemical plus nuclear propelled spacecraft for similar missions are also analyzed. (J.R.D.)

**32402** (N64-18173) STUDY OF THE APPLICATION OF ELECTRIC PROPULSION TO SPACE MISSIONS. Quarterly Progress Report No. 3. Fimple, W. R. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Mar. 1964. Contract NASw-737. 38p. (NASA-CR-53472; C-910076-3). $3.60(CFSTI).

The application of SNAP-50 to the Jupiter probe mission was considered, assuming the use of the Saturn IB launcher. The study of the lunar logistic supply operation was extended to include the use of the Saturn V as the launcher. For this mission, a performance comparison of electric propulsion with the solid-core nuclear rocket was made, and the results are presented in terms of launch rate and weight launched into earth orbit per unit weight delivered to the lunar surface as functions of the lunar supply rate. (auth)

**32403** (N64-23197) PROPELLANT FLOW METER FOR ION ROCKET SYSTEMS. Final Report. Montgomery, Keith M. (TRW Electromechanical Div., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). June 15, 1964. Contract NAS 3-2515. 115p. (NASA-CR-54070; TRW-ER-5923). $9.60(CFSTI).

A heated fin anemometer vapor flow meter was designed to operate over a flow range of $10^{-4}$ to $5 \times 10^{-2}$ g/sec with either cesium or mercury vapor at 840°F. A calibration system was developed that consisted of a boiler, superheater, metering orifice, desuperheater, and condenser. The design of the anemometer configuration was accomplished with the aid of a digital computer. The expected flow-rate response of the meter was obtained. In the low-flow-rate range ($10^{-4}$ to $10^{-3}$ g/sec), the accuracy of the meter was limited by a drift on the meter readout. A discussion of this drift and suggestions for reducing it are included. (auth)

**32404** (NASA-TN-D-2868) ARC-JET THRUSTOR FOR SPACE PROPULSION. Wallner, Lewis E.; Czika, Joseph Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1965. 71p. $3.00(CFSTI)

The arc-jet thrustor represents an engine for potential space applications requiring a specific impulse in the range from 1000 to 2000 seconds. As such it was originally thought that missions for the engine would fit somewhere between those suitable for the high thrust chemical and the very low thrust ion propulsion systems. The considerable effort expended to develop the arc thrustor has resulted in operation in the power range from 1 to 200 kilowatts, at specific impulse levels between 1000 and 2000 seconds, and for continuous running as long as 500 hours with overall efficiency up to 55 percent. Progress has been made on many of the early operating problems such as electrode-erosion, nozzle-cooling, and propellant-feed systems. In addition, theories have been advanced to explain, at least partially, the electric-arc operation. In substance then, the thermal arc-jet thrustor is now fairly well developed. Because of several factors unrelated to impulse and efficiency levels, however, the mission application of the arc thrustor is somewhat doubtful at the present time. These factors, for the larger arc-jet thrustor, include biological shielding, hardware availability, excessive electric generator weight, and reliability, for example. (auth)

**32405** TRANSVERSE TRAVELING WAVE PLASMA ENGINE. Heflinger, Lee; Ridgway, Stuart; Schaffer, Allan (General Technology Corp., Torrance, Calif.). AIAA(Am. Inst. Aeron. Astronaut.) J., 3: 1028-33(June 1965).

Experimental performance of a plasma engine shows a strong accelerative coupling between the moving transverse magnetic field and the plasma propellant. There were 160 kw of power transferred to a helium plasma with 50% of this initially appearing as axially directed kinetic energy. However, at present, half of the energy given to the plasma is ultimately lost to the propulsion tube walls causing a serious degrading of the useful efficiency. (auth)

**32406** PROPERTIES OF POROUS TUNGSTEN FOR SURFACE IONIZERS. Wilson, Robert G.; Schwarzkopf, Peter; Seele, Gordon D.; Hon, J. F. (North American Aviation, Inc., Canoga Park, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1048-59(June 1965).

The structural properties of porous W ionizers sintered from powders of grain sizes from 0.1 to 74 $\mu$ were investigated by gas-flow and metallographic techniques. The quantitative influence of porosity and further sintering on the structural characteristics are presented. The experimental results indicate that powders of less than 1- or 2-$\mu$ dia cannot be used to fabricate satisfactory sintered porous ionizers unless significant advances are made in the techniques of powder metallurgy and sintering. Because the ionizer permeability and specific periphery increase with increasing porosity at a given powder size, a high ionizer porosity at any given powder size (pore diameter) is expected to be desirable for electrical propulsion applications. The apparent perveance of all of the ionizers was observed to increase slightly with increasing ion-current density and to decrease with increasing ionizer powder size. The operating characteristics of the 0.9-$\mu$ ionizer deteriorated severely with operating time at operating temperatures above 1100°C. The ionization efficiency decreases with increasing ion-current density at constant temperature (with some exceptions), and the ionization efficiency decreases with increasing ion-current density more rapidly as the ionizer powder size (pore size) increases. The maximum ionization efficiency was observed to occur at temperatures above the critical temperature. If high values of both ionization efficiency and ion-current density are simultaneously desirable, then this work leads to the conclusion that as small an initial ionizer powder size as possible (within the lower limit imposed by sintering changes, which is, at present, about 2 $\mu$) be combined with higher ionizer temperature and high ionizer porosity. (auth)

**32407** PLASMA NONUNIFORMITY AND GRID EROSION IN AN ELECTRON BOMBARDMENT ION ENGINE. Kerrisk, Daniel J.; Masek, T. D. (Jet Propulsion Lab., Pasadena, Calif.). AIAA(Am. Inst. Aeron. Astronaut.) J., 3: 1060-6(June 1965).

The plasma in an electron bombardment ion engine of the Kaufman type has been found to be very nonuniform at the ion emission surface. This could lead to a nonuniform sputtering erosion and the destruction of the accelerator grid, because of both poor focusing of the ion beam at some points and nonuniform charge-exchange rates at different radial positions. In the first case, which can be compensated by a variable perveance geometry, the erosion rate would be expected to depend on the ion density $N^+$ whereas in the latter case it should depend on the product $N_0N^+$ where $N_0$ is the neutral particle density. In the present experiments, the plasma density has been measured with a Langmuir probe and the ion beam profile with a Faraday probe. Together with flow-rate measurements, this gives an experimental determination of $N_0N^+$. Sputtering, as a function of radial position, was measured using a segmented accelerator grid, and variations in the erosion rate were correlated to the variations in $N_0N^+$. Results indicate that the engine lifetime estimates based on average grid erosion rates will be high by a factor of 2 to 3, considering only the charge-exchange erosion contribution. (auth)

**32408** DEFINING NUCLEAR-ROCKET PERFORMANCE. Chovit, Albert R.; Kylstra, Chester D.; Plebuch, Richard K. (Thompson Ramo Wooldridge Inc., Cleveland). Astronaut. Aeronaut., 3: No. 6, 36-40(June 1965).

The performance characteristics of nuclear rocket engines for the manned interplanetary space program for the period 1975 to 1990 are defined. The requirements for Mars-stopover missions and for planetary flyby and lunar missions are discussed. An analysis is made of the performance sensitivity in terms of specific impulse, engine thrust, engine weight and vehicle weight. Orbital launch weight comparisons are made. (L.B.S.)

**32409** TOWARD MODULAR NUCLEAR-ROCKET SYSTEMS. Jordan, W. Y., Jr.; Harris, R. J.; Saxton, D. R. (Marshall Space Flight Center, Huntsville, Ala.). Astronaut. Aeronaut., 3: No. 6, 48-52(June 1965).

The development of a propulsion module consisting of a Nerva-2 class engine and a Saturn V stage is discussed. A summary of the modular approach toward the evolution of nuclear rocket-systems is illustrated, showing the various flight phases and possible applications. The stage design, selection of engine size, module applications, and development sequence is discussed. It is concluded that the propulsion module would permit a wide spectrum of space missions including near Earth, cislunar, and by clustering, manned-planetary flight. (L.B.S.)

## Vacuum Engineering

*Refer also to abstract 32838.*

**32410** (LA-3320(p.67-8)) VACUUM TECHNOLOGY. Henins, I.; Marshall, J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

A vacuum system capable of achieving pressures of $7 \times 10^{-8}$ torr is described that uses no vacuum grease and no elastomer seals other than Teflon or Viton. No organic materials in the vacuum system are exposed to possible decomposition by plasma or radiation. The vacuum system is designed for plasma studies. (T.F.H.)

**32411** (LA-3320(p.69-70)) ORBITRON PUMP. Henins, I.; Marshall, J.; Tuck, J. L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The performance of "orbitron" ion-sublimation vacuum pumps for pumping plasma vacuum chambers is tested. (T.F.H.)

**32412** (WERL-15) ULTRAHIGH VACUUM TECHNIQUES. Research Report 64-9E1-441-R-2. Quarterly Progress Report, July 1–September 30, 1964. Lange, W. J.; Singleton, J. H. (Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.). Contract AT(30-1)-2823. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Thermal desorption data for the $\alpha$-phase of carbon monoxide on tungsten are now available for a wide pressure and temperature range. The data have been used to define a tungsten surface having negligible $\alpha$-phase carbon monoxide coverage, but with no depletion of the tightly bound $\beta$-phases for the study of photodesorption. The probabilities obtained, $\sim 2 \times 10^{-7}$ and $\sim 2 \times 10^{-6}$ molecules desorbed per photon, at 3000 and 2100 Å respectively are appreciably higher than those obtained for photodesorption from quartz, pyrex or nickel. The study of the interaction of oxygen with heated tungsten was completed for the range $10^{-5} - 10^{-8}$ Torr and 1200–2500°K. Estimates are made of the efficiency of removal of carbon impurities from tungsten by the process of heating in oxygen. (D.L.C.)

**32413** (WERL-2823-17) ULTRAHIGH VACUUM TECHNIQUES. Research Report 65-9E1-441-R2. Annual Report, January 1–December 31, 1964. Lange, W. J.; Singleton, J. H. (Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.). Contract AT(30-1)-2823. 48p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The operation and errors of a modulated Bayard-Alpert ion gage were studied. Oxygen pressure measurements by an ion gage, a modulated ion gage, and a mass spectrometer are discussed. The efficiency of an electron multiplier after activation and exposure to various gages was studied. Other vacuum techniques which were studied included removable of residual $CO_2$ from ultrahigh vacuum systems, tests of gold gaskets, outgassing of electron storage rings, and Teflon coating of vacuum system walls. The desorption of CO and $H_2$ from tungsten and stainless steel by heat and photons was studied. The work on the interaction of $O_2$ with tungsten was continued. (D.L.C.)

**32414** (WERL-2823-18) ULTRAHIGH VACUUM TECHNIQUES. Quarterly Progress Report, January 1, 1965–March 31, 1965. Lange, W. J.; Singleton, J. H. (Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.). Apr. 28, 1965. Contract AT(30-1)-2823. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Further work with the modulated Bayard-Alpert ion gage has partially identified the parameters affecting reproducibility. Experience with DC-705 as the diffusion pump fluid shows no advantage over less expensive fluids. Adsorption studies of oxygen on "decarbonized" tungsten indicate that atomic oxygen production can not be neglected in interpreting such experiments. An adsorbed state of oxygen requiring an energy of activation is found. (D.L.C.)

**32415** IONIZATION GAUGE CALIBRATION SYSTEM USING A POROUS PLUG AND ORIFICE. Owens, Charles L. (ARO, Inc., Arnold Air Force Station, Tenn.). J. Vacuum Sci. Technol., 2: 104-8(May-June 1965).

A calibration facility in which reproducible pressures are conveniently generated for ionization gauge calibration is described. The method uses two conductances in series, both operating in the molecular flow region, to produce low pressures at the test gauge. These low pressures are referenced to higher pressures whose measurement can be accomplished by convenient methods. The test pressure is proportional to the ratio of the two conductances. By using a porous material and a thin plate orifice, the reference pressure is reduced by a factor of approximately one million. A convenient feature of the system is the fact that once the ratio of the conductances has been determined, it can be used for many gases. Experimental results obtained using this method over the range from $10^{-3}$ to $10^{-9}$ torr are presented. (auth)

**32416** DETERMINATION OF THERMAL ACCOMMODATION OF TRANSLATIONAL ENERGY OF VAPORS AT A GLASS SURFACE. Morrison, J. A.; Tuzi, Y. (National Research Council, Ottawa). J. Vacuum Sci. Technol., 2: 109-12(May-June 1965).

A new method was developed for the determination of translational thermal accommodation coefficients, $\alpha_t$, of vapors interacting with solid surfaces and was used to measure $\alpha_t$ for bromine, iodine, benzene, naphthalene, n-hexane, and ethylacetate on Pyrex glass in the temperature region 195 to 465°K. The values obtained (0.55, 0.64, 0.37,

0.37, 0.47, and 0.46, respectively) have a probable accuracy of ± 0.06 or better and are only slightly temperature-dependent. The method, which can be easily adapted for the study of interactions with surfaces other than glass, requires the measurement of the mean velocity of molecules leaving the solid surface. This is accomplished by passing a selected beam of the molecules through the sensitive volume of an ion gage. The only restriction on the method is that the pressure of the vapor at the temperature of the wall of the gage should be very low (e.g., $10^{-12}$ torr). (auth)

**32417** A MASS SPECTROMETRIC STUDY OF THE OUTGASSING OF SOME ELASTOMERS AND PLASTICS. Barton, R. S.; Govier, R. P. (United Kingdom Atomic Energy Authority, Culham, Abingdon, Berks, Eng.). J. Vacuum Sci. Technol., 2: 113-22(May-June 1965).

Information on the outgassing properties of a number of plastic materials was obtained by the use of a bakeable mass spectrometer. This was fitted with vacuum locks to avoid affecting the residual gas compositions by introduction of the sample. Each material was examined after, it had been pumped for an acceptable pumpdown time, it had been baked in vacuo at its maximum permissible temperature, re-exposure to the laboratory atmosphere followed by the same period of pumping as originally adopted. The majority of the materials examined showed water to be the main component of outgassing. In general, bakeout in vacuo produced a permanent reduction in hydrocarbon evolution, but after re-exposure to laboratory air the rate of water vapor evolution was comparable with that originally observed. (auth)

# GEOLOGY AND MINERALOGY

## General

*Refer also to abstract 32331.*

**32418** THE ABSOLUTE ABUNDANCE OF THE LITHIUM ISOTOPES IN NATURAL SOURCES. Svec, Harry J.; Anderson, Arthur R. Jr. (Ames Lab., Ames, Iowa). Geochim. Cosmochim. Acta, 29: 633-41(June 1965). (IS-1044)

The absolute abundance of the lithium isotopes in natural sources from North America and Africa was determined. The absolute $^6Li/^7Li$ ratio from thirteen spodumene samples was found to be 0.08182 ± 0.00033. This ratio for a batch of reagent $Li_2CO_3$ was found to be 0.07926 and for $Li_3NaPO_4$ from Searle's Lake was found to be 0.07957. Considering the thirteen spodumene samples to represent the principal commercial sources of lithium, an atomic weight of 6.9403 ± 0.0005 was calculated for the element on the basis of these absolute abundances and values for the nuclidic masses. (auth)

**32419** RELATION OF CARBON 14 CONCENTRATIONS TO SALINE WATER CONTAMINATION OF COASTAL AQUIFERS. Hanshaw, Bruce B. (Geological Survey, Washington, D. C.); Back, William; Rubin, Meyer; Wait, Robert L. Water Resources Res., 1: 109-14(First Quarter 1965).

A radioisotope method was developed as an aid in detecting the contamination of coastal aquifers by sea water. This method is based on the concept that, owing to the high $^{14}C$ content of ocean water and the low $^{14}C$ content of the deep saline groundwater in the coastal region, the source of contaminating salt water might be identified by determining whether the water in the contaminated portion of the potable-water aquifer has a higher or lower $^{14}C$ content than the water from the uncontaminated portion of the aquifer. That is, a $^{14}C$ content of the contaminated water greater than the $^{14}C$ content of the potable water would indicate that the recent ocean might be the source of contamination. If, on the other hand, the $^{14}C$ content of the contaminated water is equal to or lower than that of the potable water from the aquifer (depending on the $^{14}C$ concentration of water in the underlying formation), then the underlying formation is the source of contaminating water. In a study to determine the origin of saline water in the Ocala Limestone aquifer near Brunswick, Georgia, the following sources were analyzed for $^{14}C$ and deuterium concentrations: potable water from the Ocala Limestone, contaminated water from the Ocala Limestone, saline water from the underlying Claiborne Group, and nearby ocean water. The chloride concentration of the groundwater ranges from about 25 ppM in the potable water to more than 2000 ppM in the deeper parts of the Claiborne Group. From an interpretation of piezometric maps and other hydrologic data, previous investigators had concluded that the source of the contaminating water was the Claiborne Group and not the nearby ocean. The essentially uniform range of low values of −965 to −987% of the modern standard (National Bureau Standard $^{14}C$-oxalic acid) for the $^{14}C$ activity of the groundwater samples (regardless of the degree of contamination) is in agreement with this conclusion. If recent ocean water, which had a $^{14}C$ value of +285%, were the source of contamination, the contaminated water would have had a $^{14}C$ activity higher than the activity of the fresh water. Deuterium analyses are not inconsistent with the interpretation that water from the Claiborne Group, rather than recent ocean water, is the source of the contaminating water. The concurrence of the hydrologic and the isotopic data in this area where the hydrology is well known suggests that isotopic analysis may be used to identify the origin of water in different portions of a hydrologic environment. Further applications of isotopes to identify various sources of water within a hydrologic system are proposed to aid in the solution of problems in which the hydrologic data are inconclusive. Another isotopic ratio suggested as a seawater label is $^{32}S:^{34}S$. It is known that the isotopic composition of the $SO_4^{-2}$ ion varies little in sea water and may differ widely in sulfate ions from other sources such as ancient evaporites. (BBB)

## Natural Radioactivity and Fallout

**See also HEALTH AND SAFETY.**

*Refer also to abstract 31711.*

**32420** (ORNL-P-1239) MOVEMENT OF $^{137}Cs$ BY RUNOFF, EROSION, AND INFILTRATION ON THE ALLUVIAL CAPTINA SILT LOAM. Rogowski, A. S.; Tamura, Tsuneo (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 35p. (CONF-650523-1) Dep. (mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on Radiation and Terrestrial Ecosystems, Richland, Wash.

Five mC of $^{137}Cs$ were applied in the form of spray to the 5-$m^2$ plots of the Captina soil in Tennessee under bare, clipped meadow, and tall meadow cover conditions. During the initial 81-day period agreement was observed between predicted and experimental soil loss. Linear relationship on a full log scale was found between the soil and $^{137}Cs$ loss. On the plots with vegetation, it was found that practically all of the $^{137}Cs$ applied to the areas covered with vegetation was initially on the plant and litter material. The leaching of $^{137}Cs$ from the vegetation began to level off towards the end of the study period (20.5 cm of rain). At the end of the 81-day period, the bare plot had lost 11.9% of the cesium while the clipped meadow and tall meadow plots had lost 5.1% and 2.6% of their cesium respectively. (auth)

**32421** (PNE-237F) FOOD-CHAIN RELATIONSHIPS OF RADIOSTRONTIUM IN THE SEDAN FALLOUT FIELD. Martin, William E.; Turner, Frederick B. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Mar. 1965. Project 62.83 of PROJECT SEDAN. 74p. Dep.; $3.00(cy), 2(mn) CFSTI.

Plant samples and rabbits were collected before and at various times up to 33 days after the detonation from 20 representative locations in the Sedan fallout field. Radiochemical analyses were made to determine the concentrations of $^{89}Sr$ and $^{90}Sr$ in dry plant samples and in the bone ash of rabbits at the times of collection. Estimates of initial gamma dose rates ($R_0$ = mr/hr, 3 ft above ground, 24 hr after the detonation) were obtained from aerial survey data. The average concentrations, build-up, and later decline of radiostrontium in the bone ash of rabbits collected in the Sedan fallout field were apparently to the initial concentrations of radiostrontium on the fallout-contaminated plants consumed by the rabbits; the weight of contaminated plant material consumed per rabbit per day; the weight of bone ash per rabbit; the fraction of ingested radiostrontium which was assimilated and deposited in bone; the effective half-life of radiostrontium on fallout-contaminated plants; and the effective half-life of radiostrontium in the skeleton. A mathematical model incorporating these parameters was formulated and found to function satisfactorily with parameter values derived from the radiochemical data. Estimates of the total doses (rad) delivered by $^{89}Sr$ to rabbit bone were based on the model. The estimated doses to individual rabbits ranged from 0.11 to 9.48 rad, and the average was 1.12 ± 0.36 rad. While the model seems to provide an adequate explanation of the quantitative-kinetic relationship between average initial concentrations of radiostrontium on plants and subsequent average concentrations in rabbit bone ash, the parameter values used in fitting the

hypothetical curves to the observed data points could be inaccurate; and even if the derived parameter values are accurate, they might not be applicable to other fallout fields. Some of the factors which influence the parameters considered in the model, and the major sources of error in estimating specific parameter values were discussed at length. A mathematical model was proposed to provide at least a partial explanation of the quantitative-kinetics of $^{89}Sr$ or $^{131}I$ on pasture plants, in cow's milk, and in human tissues (bone and thyroid) following fallout from a single nuclear detonation. The potential value of the proposed model as an aid in the study of human food-chain kinetics or for the interpretation of radiochemical data was illustrated by means of hypothetical calculations. (40 references. (auth)

**32422** (UCRL-12407) NEUTRON-INDUCED ACTIVITY IN EARTH AND SEA-WATER FROM BURIED AND SURFACE NEUTRON SOURCES. Lessler, Richard M.; Guy, Frank W. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 9, 1965. Contract W-7405-eng-48. 62p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Results are presented of computer calculations of activation of NTS soil, granite, and seawater by buried neutron sources of various neutron energy. Also presented are calculations of spatial distribution of neutron captures in the soil from a surface neutron source. The contribution to fallout from soil activation may be calculated from these data. (auth)

**32423** BACKGROUND RADIATIONS AND THEIR ORIGINS. Mayneford, W. V. (Inst. of Cancer Research, London). Advan. Sci., 21: 127-?(July 1964).

Various aspects of radioactivity in the human environment are surveyed. Discovery of the existence of a natural fallout cycle is discussed. One member of the U Series, $^{222}Rn$, formed in soil as a gas during the disintegration of $^{226}Ra$, can deliver large doses to the roots of plants. This Rn, diffusing upwards, disintegrates into such products as lead, bismuth, and polonium, which may be brought down again in rain. Polonium-210 is sometimes found on the surface of grass in amounts roughly proportional to the rainfall. This $^{210}Po$ may follow the food chain to the soft tissues of man. A survey of the natural radioactive materials found in drinking waters in the U.K. is presented which revealed their presence even in deep wells. Some spa waters are very active and contain, besides Ra, relatively large amounts of Rn, far in excess of that to be expected from their Ra contents. Assays of natural radioactivity in foods show high values, particularly in cereals, and 70% of the $\alpha$ radioactivity normally eaten per day by the population of the U.K. comes from this source. The mean daily intake of Ra per day in the U.K. is estimated as 2.5 $\mu\mu$C, but much the largest absolute amount of radioactivity taken in per day is as $^{40}K$ (3000 $\mu\mu$C). Humans excrete nearly the same amount and do not grow more active with age. The type of house in which people live also considerably affects the radiation received. Fallout radioactivity originating from nuclear weapons testing is also considered. (TCO)

**32424** CONCENTRATION OF THE NATURAL RADIOACTIVITY IN THE ATMOSPHERE NEAR JASSY AND ITS DAILY VARIATIONS. Mageru, V.; Rezlescu, N. (Institut de Chimie, Iasi). Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 99-106(1964). (In French)

An apparatus designed for the filtration of air near the soil has the principal advantage of simultaneous determination of $\alpha$ and $\beta$ particles. The concentrations of radon in air near ground level and its daily variations were determined. The value for the radon concentrations at Jassy were $10.62 \times 10^{-18}$ C/cm$^3$. This agreed with the values found by previous studies. The daily variation of the radon concentration was a simple curve with one maximum and one minimum during the day. The maximum was at 8:00 AM and the minimum at 4:00 PM. (J.S.R.)

**32425** DYNAMICS OF TRANSPORT OF ATOMIC AEROSOLS TO THE EARTH. Mageru, Victor (Institut de Chimie, Iasi). Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 107-16(1964). (In French)

The investigation of the radioactivity of dry and liquid fallout in the air near the ground made it possible to critically compare the atomic aerosols in the atmosphere. It was established that the specific activity of different fractions differ from each other. This difference showed that the different layers of a given radioactive cloud have different concentrations. The relation of the specific activity to the quantity of fallout at different time intervals indicated the presence of three types of transport of aerosols to the ground. From the results of the investigation of the two types of fallout, it was established that the percent of the fallout to the total activity depends on the time of the year and meteorological factors. (tr-auth)

**32426** YEARLY SURVEY OF ATMOSPHERIC RADIOACTIVE FALLOUT. Mageru, Victor; Chiriac, Vasile (Institut fur Chemie, Iasi). Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 117-24(1964). (In German)

The results of the daily measurements of the radioactivity of the dry and liquid fallout in Jassy from September 1, 1958, to September 1, 1963 are reported. The existence of a seasonal maximum was established and an explanation for the occurrence of this maximum is given. The relation between the variation of the radioactivity of the fallout and the alteration of meteorological factors served as the basis for this explanation. (tr-auth)

**32427** OBSERVATION OF FALLOUT AROUND OUR LABORATORY. Mamuro, Tetsuo; Fujita, Akira (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 1-4(Mar. 1965).

The results of observation during 1964 on rain-out, concentration of fallout activity in the atmosphere, and fallout collected in a basin are reported. Fresh nuclear debris from the first Chinese nuclear test explosion was detected first in airborne dust on 18 October and appeared in rain water on 20 October. Many highly radioactive fallout particles were found and collected on 19 and 20 October. (auth)

**32428** MICROSCOPE EXAMINATION OF HIGHLY RADIOACTIVE FALLOUT PARTICLES FROM THE FIRST CHINESE NUCLEAR TEST EXPLOSION. Mamuro, Tetsuo; Fujita, Akira (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 5-15(Mar. 1965).

Highly radioactive fallout particles from the first Chinese nuclear test explosion were examined microscopically. The result was compared with that obtained on the highly radioactive fallout particles which originated from the Russian large-scale air bursts in the autumns of 1961 and 1962. Some differences were found between them and considered to be caused by the fact that the Chinese explosion was a small-scale land surface burst while the Russian ones were large-scale air bursts. (auth)

**32429** RADIONUCLIDE FRACTIONATION SEEN IN THE FALLOUT FROM THE FIRST CHINESE NUCLEAR TEST EXPLOSION. Mamuro, Tetsuo; Yoshikawa, Kazuko (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 16-22(Mar. 1965).

Two types of radionuclide fractionation were found in the highly radioactive fallout particles that originated from the first Chinese nuclear explosion. The first type is the same as that observed formerly in the highly radioactive particles that originated from the Russian large-scale air bursts in the autumns of 1961 and 1962. The radiochemical composition of the particles affected by the first type of fractionation is much enriched in $^{95}Zr + {}^{95}Nb$ and impoverished in $^{103}Ru$. The second type was not observed in the Russian particles. The particles affected by the second type of fractionation are much enriched in $^{103}Ru$ and impoverished in $^{95}Zr + {}^{95}Nb$. The particles of exceedingly higher activity appeared to be generally affected by the second type of fractionation. (auth)

**32430** DETECTION OF $^{54}Mn$, $^{60}Co$ AND $^{239}Pu$ IN FALLOUT. Mamuro, Tetsuo; Matsunami, Tado (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 23-8(Mar. 1965).

Some rather qualitative experimental results are reported on the three induced radionuclides in fallout: $^{54}Mn$, $^{60}Co$, and $^{239}Pu$. $^{54}Mn$ was detected by $\gamma$ spectrometry combined with a chemical separation procedure. The existence of $^{60}Co$ was confirmed by $\gamma$-$\gamma$ coincidence spectrometry using two crystals. $^{239}Pu$ was detected by $\alpha$ spectrometry using a Frish grid chamber. More qualitative investigation is now in progress. (auth)

**32431** BETA AND GAMMA RAYS FROM THE FALLOUT ACCUMULATED ON THE GROUND SURFACE. Fujita, Akira; Yoshikawa, Kazuko (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 29-32(Mar. 1965).

Terrestrial $\beta$- and $\gamma$-ray intensities differ from place to place depending on the materials and the state of ground surface. Background counting rates of a G-M counter were measured above a clover field, above a concrete surface outdoors and above a bare ground in the laboratory yard, and they were compared with one another. Gamma spectra of the ground surface materials and the iron concentration near the ground surface were also measured. The intensities of both $\beta$ and $\gamma$ rays were found to be highest above the clover field, and this was assumed to be caused by the circumstances that the clover field is highest in fallout accumulation while it is lowest in absorption of $\beta$ and $\gamma$ rays by surface materials. (auth)

**32432** GEOCHEMICAL AND GEOLOGICAL INVESTIGATIONS BY MEANS OF NUCLEAR PHYSICAL METHODS. Kovach, Adam (Inst. of Nuclear Studies, Hungarian Academy of Sciences, Debrecen). Fiz. Szemle, 15: 386-7(Dec. 1964). (In Hungarian)

Several new methods, requiring collaboration between physicists, chemists, and geologists, were developed and applied in the Institute of Nuclear Studies. Szalay and Földváry determined the isoradiation relations in the Velence and Mecsek Mountains and discovered anomalies in the radioactivities of the area. They found that certain anthracites in the transdanubian District contain richer U deposits than could be expected from a study of the environment. A subsequent broad investigation of the U content of all Hungarian anthracite deposits allowed to postulate a mechanism causing the enrichment of U in biolites: it is due to a cation-exchange-type sorption process involving the insoluble humic acids. The theory served as a basis for an industrial method to sorb fission products on humic materials. In another series of tests, the isotopic concentration of Hungarian Pb deposits was determined. The results indicate that the Transdanubian deposits are of paleozoic origin, while most of the North Hungarian Pb deposits exhibit isotopic ratios corresponding to a more recent geological age. The Rb/Sr method was used to determine the age of certain crystalline minerals; on the basis of these results the age of granites from the Mecsek Mountains was estimated at 285 million years. (TTT)

**32433** THORIUM AND URANIUM CONCENTRATIONS, AND THE ISOTOPIC COMPOSITION OF STRONTIUM IN THE DIFFERENTIATED TASMANIAN DOLERITES. Heier, K. S.; Compston, W.; McDougall, I. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 29: 643-59(June 1965).

The differentiation of the Tasmanian dolerites of tholeiitic affinities was studied with respect to their Th, U, K, and Rb contents as well as to their initial $^{87}Sr/^{86}Sr$ ratios. A linear relationship between Th and K, and U and K was observed. The value of the $^{87}Sr/^{86}Sr$ ratio stayed constant throughout the differentiated series, and only a slight increase in the K/Rb ratio with differentiation was noted. The observed Th/K, U/K, K/Rb and $^{87}Sr/^{86}Sr$ ratios were similar to those observed in "granitic" or "crustal" rocks, and were markedly different from those commonly observed in basalts. The implications of these observations on hypotheses on the source of the doleritic magmas are discussed. Contamination of basalt magma by crustal material, though a distinct possibility, is not favored because of the homogeneity and uniform chemical composition of the large masses of doleritic intrusions. The low value of the K/Rb ratio (~210) could not easily be derived from contamination of basalt magma with average crustal materials. It was concluded that if contamination was active it was in the form of selective diffusion of certain elements into the magma. If the magma was generated from within the crust the temperature gradient in Tasmania was considerably steeper in the Jurassic than at present; if it was from the mantle an unusual composition of the mantle material under Tasmania is indicated. (auth)

**32434** ESTIMATION OF THE $^{90}Sr$ IN THE ISRAELI DIET DURING 1962-1963 AS BASED ON THE RADIOANALYSIS OF MILK. Feige, Y; Eisenberg, A; Passy, N; Stiller, M. (Soreq Research Establishment, Yavne, Israel). Health Phys., 11: 629-35(July 1965).

Concentrations of $^{90}Sr$ in milk samples from eight collection stations in various parts of Israel are presented for the period October 1961 to September 1963. Values for $^{89}Sr$, $^{137}Cs$, and $^{140}Ba$ are given for part of this period. The average concentration of $^{90}Sr$ at the end of 1961 was less than 3.5 $\mu\mu c$/g Ca. Strontium-90 values were somewhat higher, 4 to 8 $\mu\mu c$/g Ca from March 1962 to winter 1963. A further rise began in February 1963, due to the new series of atmospheric nuclear tests. Strontium-90 values were often about 15 $\mu\mu c$/g Ca during the summer of 1963. The $^{90}Sr$ concentration in the milk from each collection station seemed to be partly related to the rainfall in that particular region. Cesium-137 concentrations in milk were always about four fold higher than the corresponding $^{90}Sr$ concentrations. Nevertheless the relative contribution of $^{137}Cs$ intake to the long term exposure of human tissues to radiation is small compared with the dose bone receives from ingested $^{90}Sr$. Estimates for the average daily $^{90}Sr$ intake of the Israeli population, based on food balance sheets, are 4.6 $\mu\mu c$ $^{90}Sr$/day in 1962 and about 12 $\mu\mu c$ $^{90}Sr$/day in 1963. Imported wheat from North America was apparently the principal single source of dietary $^{90}Sr$ for the Israeli population. Infants consuming only milk received an average of 3.1 $\mu\mu c$ $^{90}Sr$/day in 1962 and 6.2 $\mu\mu c$ $^{90}Sr$/day in 1963. (auth)

**32435** STATISTICAL PROPERTIES OF RADIOACTIVE AEROSOLS. Metzger, C.; Rossel, J. (Universite, Neuchatel, Switzerland). Helv. Phys. Acta, 38: 277-33 (1965). (In French)

The material collected on filters placed under the wing of a plane flying at altitudes from 4,000 to 10,000 m above the Swiss territory was measured for their radioactivity using nuclear emulsions. The results of the measurements, made 14 and 18 months after the collection, were statistically analyzed. It was established that the activity distribution of beta-active aerosols follows in part a Gaussian-logarithmic law. The beta activity is proportional to the surface or to the volume of the particle for aerosols of low activity. The distribution has an excess of highly active hot points. Particles that seem to be exclusively alpha active were found in the radioactive dusts. (J.S.R.)

**32436** DEBRIS PARTICLES RESULTING FROM THE CHINESE NUCLEAR BOMB TEST. Sisefsky, Jan (Research Inst. of National Defence, Stockholm). Nature, 206: 1140-1(June 12, 1965).

Forty-three debris particles from the Chinese nuclear weapon test on October 16, 1964 were identified in Swedish ground-air samples. Their diameters were measured and beta activities determined. The particles were found to have a very low specific activity—about a factor of 100 less than that normal for particles from Soviet and American tests. (M.C.G.)

**32437** CARBON-14 IN NATURE. Haxel, Otto (Universitat, Heidelberg). Naturw. Rundschau, 15: 133-40 (Apr. 1962). (In German)

This review of the natural occurrence of $^{14}C$ includes a description of the generation of $^{14}C$ in the atmosphere by

cosmic neutron collisions with $^{14}N$, the extent of the $^{14}C$ reservoir in the biosphere, techniques for measuring $^{14}C$ in archeologic artifacts, $^{14}C$ concentrations at various marine depths and in drinking water supplies, and uses of $^{14}C$ analyses for archeological studies. Most of the $^{14}C$ present in the atmosphere was generated by the reaction $^{14}_{7}N + {}^{1}_{0}n \rightarrow {}^{14}_{6}C + {}^{1}_{1}H + 0.626$ Mev. Such cosmic production of $^{14}C$ occurs at the rate of 2.6 molecules of $^{14}CO_2$ formed per sec-cm$^2$, or about 10 kg $^{14}C$ formed per year. Considering this annual production rate, this results in a total reservoir on earth of about 80 tons of $^{14}C$ or 365 MC, of which 2% is in the atmosphere and 96% in marine deposits. The changing level of $^{14}C$ over the span of the earth's history is discussed, and the application of this principle in age determination of archeologic objects explained. Atmospheric levels of $^{14}C$ assayed from 1956 show a peak value in 1959, presumably representing additional formation of $^{14}C$ by neutrons released during thermonuclear weapons testing. The maximum rise of $^{14}C$ in air and water observed in 1959 represented a 30% increase over the basal level, and a lower max (25%) was seen in 1960. The largest reservoir of $^{14}C$, in the sea, is discussed in terms of variations at different sea depths and latitudes in the Pacific and Atlantic Oceans. Concentrations of $^{14}C$ in various subsurface fresh water samples obtained in Germany and in the Sahara Desert are tabulated and discussed. Ages of items of prehistorical interest, as estimated by $^{14}C$ assays, are presented. (BBB)

**32438** RADIOACTIVE RAIN, SNOW AND ATMOSPHERIC CONTAMINATION OBSERVED IN NAGAOKA CITY, JAPAN. REPORT X. TOTAL INTENSITIES OF THE RADIOACTIVE FALLOUT DURING THE YEAR 1964. Kobayashi, Ugoro; Sasaki, Hideho (Niigata Univ., Japan). Niigata Daigaku Kogakubu Kenkyu Hokoku, No. 14, 1-14 (Mar. 1965). (In Japanese)

As a sequel to research over the last nine years, the artificial radioactivity of rain, snow, and airborne debris in Nagaoka city due to nuclear detonations was also investigated in 1964. The radioactive fallout had diminished month by month until the middle of October 1964 under a moratorium on nuclear explosion tests; then because of the test by continental China it increased rapidly. Contamination by the test diminished in November, apparently because the site of the Chinese test was near Japan and the scale of the explosion was comparatively small. (auth)

**32439** ON RADIOACTIVE GIANT PARTICLES CONTAINED IN RADIATION FALLOUT. REPORT IV. Kobayashi, Ugoro; Sasaki, Hideho (Niigata Univ., Japan). Niigata Daigaku Kogakubu Kenkyu Hokoku, No. 14, 15-20 (Mar. 1965). (In Japanese)

Radioactive giant particles (highly radioactive fallout particles) due to the nuclear detonation in continental China on the 16th of October, 1964, were found on the 19th and 20th of October at Nagaoka. The radioactivity per particle was low but the density per unit area was larger than in cases of nuclear tests in the U.S.S.R. in the past and the contamination from them per unit area was about 8.5% of the gross contamination in October. There were many radioactive giant particles larger than 14$\mu$ in diameter and gourd-shaped. Their velocities of disintegration were rapid in general but varied. The radioactivities of giant particles per unit volume were within the limits of 0.005 ~ 0.03 $\mu\mu$C/$\mu^3$ at 50 days after the explosion. (auth)

## Site Survey and Selection

*Refer also to abstract 32449.*

**32440** (CONF-650201(p.81-97)) SITING OF NUCLEAR POWER PLANTS ON THE WEST COAST. Mautz, F. F. (Pacific Gas and Electric Co., San Francisco, Calif.).

A summary is presented of the experiences of the Pacific Gas and Electric Company in nuclear power plant siting, starting with the Humboldt Bay unit and ending with its plans up to the year 1980. The Bodega Bay project and its cancellation are discussed in some detail. Three possible sites are described briefly: Nipomo, South Moss Landing, and Montezuma. Coordination with public and private agencies is discussed. (D.L.C.)

## Techniques and Equipment

*Refer also to abstract 33652.*

**32441** RADIOACTIVITY MEASUREMENTS FOR DETERMINATION OF THE FIRN LAYERS OF AN ALPINE GLACIER. Ambach, W.; Eisner, H. (Universitat, Innsbruck). Naturwissenschaften, 52: 154(1965). (In German)

It was shown that, as a result of the relation between atomic tests and the total beta activity of the firn layers, it is possible to date the firn layers by measurement of the radioactivity of the firn in the Antarctica. Such a dating method can also be applied in the accumulation range of a tempered Alpine glacier although a washing out of the radioactive layers by percolation of the melt water is to be expected. (J.S.R.)

**32442** URANIUM-SERIES DATING OF CORALS AND OOLITES FROM BAHAMAN AND FLORIDA KEY LIMESTONES. Broecker, Wallace S.; Thurber, David L. (Columbia Univ., New York). Science, 149: 58-60(July 2, 1965).

Samples of fossil coral and oolite from marine formations of the Bahamas and the Florida Keys were analyzed for their concentrations of uranium and thorium isotopes. Ages calculated from the ratio $^{230}Th:{}^{234}U$ clearly indicated periods of marine limestone formation at about 85,000, 130,000, and 190,000 years ago, implying that the surface of the ocean was then close to its present level. (auth)

**32443** URANIUM ORE DETECTION. Skvarla, John E. (to Union Carbide Corp.). U. S. Patent 3,158,741. Nov. 24, 1964. Filed June 26, 1961.

A method and device are described for locating U ore deposits in which the drill holes may be spaced up to half mile apart, and the device can be readily transported in a truck or carried by one man. The gas in the drill hole into the substrata region of the earth is evacuated from the hole through a probe member without dilution with the atmosphere through a radon absorber and measuring device. The probe member has an inlet and outlet for the gas, and a conduit means connects the outlet of the probe member with the radon absorber. Inflatable sealing means positioned along the probe member-conduit axis at a point above the probe member inlet are adapted to seal against the walls of the drill hole to prevent the flow of fluid from the inlet of the drill hole into the inlet of the passage in the probe member. Radiometric means determine the gamma activity of the radon absorbed to provide a measure of the U producing the radon. (B.L.M.)

**32444** NUCLEAR RESONANCE FLUORESCENCE LOGGING. Yule, Herbert P. (to California Research Corp.). U. S. Patent 3,171,961. Mar. 2, 1965. Filed Dec. 30, 1960.

A method is described for identifying only carbon or oxygen nuclei in an earth formation traversed by a well bore by detecting the resonant fluorescent $\gamma$ rays emitted solely by such nuclei when excited to a characteristic resonant energy level. A target of $^{12}C$ $^{16}O$, or material convertible to these nuclei in an excited state is positioned in the well bore and bombarded with nuclear particles of energy suitable to produce the desired excited state. Gamma rays from these excited nuclei excite carbon and oxygen nuclei in the earth formation, and the $\gamma$ rays from the formation are measured by an appropriately placed detector. The number of $\gamma$ rays of selected energy indicates the content of C or O in the formation. (A.G.W.)

## Thorium and Uranium Minerals

**32445** SOME OBSERVATIONS ON THE URANIUM AND THORIUM DISTRIBUTIONS IN ACCESSORY ZIRCON FROM

GRANITIC ROCKS. Ahrens, L. H. (Univ. of Cape Town). Geochim. Cosmochim. Acta., 29: 711-16(June 1965).

The uranium and thorium distributions in seventy-two specimens of accessory zircon from granitic rocks were examined. Frequency distributions of both elements were positively skewed and the distributions were clearly not normal; both distributions approximated lognormality. The dispersion of the thorium concentration was distinctly greater than that of uranium; ionic radii differences may be the cause. The ratio Th/U was also positively skewed, and whereas the average ratio was 0.47, the modal (most frequent) value was ~0.35. Though not well-developed, there appeared to be a distinct correlation between uranium and thorium in the zircon under consideration. (auth)

# HEALTH AND SAFETY

*See also* BIOLOGY AND MEDICINE — Radiation Hazards and Protection.
GEOLOGY AND MINERALOGY — Natural Radioactivity and Fallout

*Refer also to abstracts 31696, 31712, 31803, 31810, 32101, and 32544.*

**32446** (AD-609202) SOME PUBLIC VIEWS ON CIVIL DEFENSE PROGRAMS. Nehvevajsa, Jiri; Brodie, Dorothy V.; Krochmal, Donna; Pomeroy, Richard (Pittsburgh Univ., Pa. Dept. of Sociology). Dec. 1964. Contract OCD-OS-63-48. 112p. $4.00(CFSTI).

A survey of Civil Defense and Cold War Attitudes was conducted in mid-1963 using a national probability sample of 1,434 Americans. The sample's orientation to civil defense systems and cold war issues was analyzed in terms of relevant social and personal characteristics. Interviews dealt with the likelihood and desirability of various alternative shelter systems and cold war outcomes. In addition to the data collected on attitudes and opinions on the central issues, respondents were asked a series of questions specifying pertinent elements of their social and personal attributes. These dealt with such topics as marital status, family income, education, age, etc., and a variety of other questions tapping these dimensions. Results indicated young, well-educated people are the best informed. (C.H.)

**32447** (ANL-7020(p.175-97)) REACTOR SAFETY. (Argonne National Lab., Ill.).

The studies of metal-water reactions included the reaction of fuel elements with steam at 1500°C and 15 psig, reactions of refractory metals and iron with steam, laser heating of Al foils in water, in-pile studies (TREAT and Kiwi-TNT), and calculational studies. The ignition of preirradiated U in air and oxygen was studied. Fast reactor safety studies which were recently initiated are described. (D.L.C.)

**32448** (BNWL-27) BATTELLE-NORTHWEST FUEL FABRICATION EXPERIENCE WITH HIGH-EXPOSURE PLUTONIUM. Merker, L. G.; Faust, L. G.; Bailey, W. J.; (and others) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT(45-1)-1830. 51p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

The radiation studies performed and the equipment and process modifications required to permit safe, routine, efficient handling of high-exposure Pu (to 30% $^{240}$Pu) are described. By effective use of lead glass panels, lead-impregnated gloves, portable shielding, and good work habits, the fuel fabrication with high-exposure Pu was accomplished with operator exposure comparable to that obtained with unshielded low-exposure Pu. (W.L.G.)

**32449** (CONF-650201) NUCLEAR POWER REACTOR SITING. A National Topical Meeting [Held] February 16-18, 1965, Los Angeles, California. Ashley, R. L., ed. (American Nuclear Society, Los Angeles, Calif.). Dep.; CFSTI.

A total of 30 speeches and papers are included which are grouped into sessions dealing with: comparative public health aspects of nuclear safety, reactor siting regulations, siting economics, influence of site location on reactor design, comparative national policies on reactor siting criteria, and public acceptance of nuclear power. Summaries of comments, questions, and answers are also included. Separate abstracts were prepared for 28 of the speeches and papers. (D.L.C.)

*For abstracts of individual papers see: 32325, 32440, 32450, 32451, 32452, 32453, 32454, 32455, 32456, 32457, 32458, 32459, 32460, 32461, 32462, 32463, 32464, 32465, 32466, 33528, 33593, 33594, 33595, 33596, 33597, 33598, 33599, and 33600.*

**32450** (CONF-650201(p.1-7)) [SITING OF NUCLEAR POWER PLANT]. (American Nuclear Society, Los Angeles, Calif.).

Reactor siting is shown to involve four professional areas: the design of reactors to meet safety specifications, utility economics, public risk, and public relations. The conflict between the four prevents the production of sound, long-term criteria for reactor siting. Public acceptance of risks is discussed in relation with non-nuclear industries. The need for a unified viewpoint in the nuclear industry that nuclear power is safe, is emphasized. (D.L.C.)

**32451** (CONF-650201(p.9-19)) SITING OF ELECTRIC POWER PLANTS. Knapp, Sherman R. (Connecticut Light and Power Co., Hartford).

Broad siting patterns and trends for steam electric plants are surveyed. Among the new factors making themselves felt within the last decade is atomic power. The problem of public acceptance of steam plants in general and of atomic power plants in particular is considered, and some suggestions for public information and research and development are given. Finally, the need for a positive attitude in solving siting problems is emphasized. (D.L.C.)

**32452** (CONF-650201(p.20-2)) SITING OF INDUSTRIAL PLANTS. Kilian, D. J. (Dow Chemical Co., Freeport, Tex.).

The experiences of the Texas Division of Dow Chemical Co. with several incidents in Freeport are described. The fact that none of these incidents were very serious is attributed to careful pre-planning and public confidence in the company. The telephone seizure system, whistle warning, and other disaster aids are discussed. (D.L.C.)

**32453** (CONF-650201(p.23-31)) INSURANCE VIEW OF THE RISK TO PUBLIC HEALTH AND SAFETY FROM (NUCLEAR AND NON-NUCLEAR) INDUSTRIAL PLANTS. McAllister, R. G.; Houghton, J. A. (Liberty Mutual Insurance Co., Boston, Mass.).

The need for nuclear power and for the conservation of fossil fuels is pointed out. Some non-nuclear plant accident experiences are described. The insurance view on siting criteria of non-nuclear and nuclear plants is considered, and the difficulties of insuring nuclear plants are discussed. It is concluded that the AEC site criteria and the Advisory Committee on Reactor Safeguards are one of the fundamental bases for a sound insurance program. (D.L.C.)

**32454** (CONF-650201(p.45-53)) THE ESTABLISHMENT OF STANDARDS FOR SAFETY EVALUATION OF REACTORS. Mann, Marvin M. (Atomic Energy Commission, Washington, D. C.).

A discussion is given of the principles and beliefs upon which the standards and guides for evaluation of reactors are based. It is emphasized that the primary responsibility for the safe operation of a licensed reactor rests upon the licensee. Changes in some areas are considered. The subject of technical specifications is discussed in some detail, and some work of a Task Force on this subject is described. (D.L.C.)

**32455** (CONF-650201(p.54-62)) REGULATORY STAFF EVALUATION OF NUCLEAR REACTOR HAZARDS. Doan, R. L. (Atomic Energy Commission, Washington, D. C.).

Two stages occur in the hazards review and evaluation, one at the construction permit stage and again before the issuance of an operating license. A discussion is presented of some of the philosophy and areas of inquiry of the regulatory staff in the hazards evaluation. (D.L.C.)

**32456** (CONF-650201(p.63-5)) AN OPERATOR'S VIEW OF REACTOR SITING REGULATIONS. Kettner, Robert E. (Consumers Power Co., Jackson, Mich.).

Some observations on AEC regulations are offered from

an operator's viewpoint. It is contended that the regulations are neither readily understandable nor flexible, and that they are too conservative; the distance and containment requirements are distorted. It is felt that performance-type regulations, rather than specification-type regulations, would alleviate some of the problems. (D.L.C.)

**32457** (CONF-650201(p.129-36)) THE RELATIONSHIP BETWEEN NUCLEAR SAFETY PROGRAMS AND POWER REACTOR SITING AND DESIGN. Lieberman, Joseph A. (Division of Reactor Development and Technology (AEC), Washington, D. C.).

To prevent too-conservative siting judgements, information is needed in three areas: the probability and consequences of accidents, the mechanisms of such accidents, and engineered safeguards. An account is given of the progress of the nuclear safety research and development program in these areas. (D.L.C.)

**32458** (CONF-650201(p.137-43)) RECENT TECHNOLOGICAL DEVELOPMENTS PERTINENT TO MAXIMUM CREDIBLE ACCIDENT SEVERITY AND PROBABILITY. Ergen, W. K. (Oak Ridge National Lab., Tenn.).

There are two ways in which fuel elements can overheat and release fission products: loss of coolant and nuclear excursions. A discussion is given of the eight severe nuclear excursions which occurred in reactors which were, or resembled, power reactors. The release and transport of fission products are discussed. The probability of serious accidents and its calculation are considered. (D.L.C.)

**32459** (CONF-650201(p.144-54)) RADIATION PROTECTION CONSIDERATIONS IN REACTOR SITING. McEwen, Laurance H.; Smith, James M., Jr.; Stuart, Ivan F. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.).

The radiation protection aspects of a reactor site are influenced by many factors, particularly atmospheric dispersion. A survey is made of data on certain phenomena which, if not taken into consideration, can lead to errors in estimates of radiation doses from hypothetical accidents. These phenomena are wind direction, poor diffusion, wind direction variability during inversion, release elevation, plume depletion by fallout, cloud size, and shielding by structures. (D.L.C.)

**32460** (CONF-650201(p.155-73)) ESTABLISHING SAFETY DESIGN CRITERIA FOR POWER REACTOR SITES. Goldman, M. I. (Nuclear Utility Services, Inc., Washington, D. C.); Jarrett, A. A. (Atomics International, Canoga Park, Calif.).

The effects of various engineered safeguards (containment, overpressure reduction, decontamination, and dilution) on siting distances are analyzed for a 3000-Mw(t) water reactor. The effects of multiple combinations of safeguards are considered using several power reactors as examples. Finally, the effect of reactor type on safety design criteria is discussed. (D.L.C.)

**32461** (CONF-650201(p.174-9)) MONITORING THE RELIABILITY OF ENGINEERED SAFEGUARDS. Garrick, B. J.; Gekler, W. C. (Holmes and Narver, Inc., Los Angeles, Calif.).

Current practices in measuring the reliability of engineered safeguards are surveyed. Means of improving them are considered. The use of safeguard reliability to reduce the site distance requirements is discussed. (D.L.C.)

**32462** (CONF-650201(p.183-91)) REACTOR SITING CRITERIA AND PRACTICE IN THE U. S. Beck, Clifford K. (Atomic Energy Commission, Washington, D. C.).

A discussion is presented of U. S. practice in site selection of power reactors. The need to examine the safety implications of the recent changes in nuclear power plant format (increased size, fuel, and proximity to populations) is pointed out. The various elements in the site selection process are described, and the Maximum Credible Accident concept is discussed in some detail. (D.L.C.)

**32463** (CONF-650201(p.192-200)) REACTOR SITING—THE ART OF COMPROMISE. Farmer, F. R. (Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, Risley (England)).

The various bases for site selection in different countries are described. The assessment of radiation doses and accidents from postulated accidents is discussed in some detail. The growth of siting practices in U.K. and U.S. is shown to be similar. (D.L.C.)

**32464** (CONF-650201(p.201-8)) REACTOR SITING CRITERIA AND PRACTICE IN CANADA. Laurence, G. C. (Atomic Energy Control Board, Ottawa (Ontario)).

A description is given of a method which is being developed for appraising reactor sites close to cities. Design and operating restrictions arising from the density and distribution of the surrounding population are discussed. The failure of process, protective, and containment equipment and their simultaneous occurrence are considered. (D.L.C.)

**32465** (CONF-650201(p.209-10)) REACTOR SITING CRITERIA AND PRACTICE IN JAPAN. Uchida, Hideo (Tokyo Univ. (Japan)).

Early practice in reactor siting in Japan is described. The aseismatic design of reactors is considered briefly. The safeguards of the Tokai and JPDR power plants are described. An outline is presented of the new guidelines for reactor site evaluation which was adopted by JAEC on May 27, 1964. (D.L.C.)

**32466** (CONF-650201(p.211-43)) REACTOR SITING CRITERIA AND PRACTICES IN EUROPE. Vinck, W. F. (European Atomic Energy Community).

A broad survey is presented of practices in reactor siting from the point of view of public health and safety, as they are currently applied in Europe. Site inventories, engineered safeguards, loss-of-coolant accidents, fission product release, efficiency of safety devices and containment, maximum hypothetical accidents in gas-cooled reactors, and site variables under various conditions are discussed. (D.L.C.)

**32467** (IDO-12042) BIOLOGICAL AVAILABILITY OF RADIONUCLIDES IN CALCINED WASTE. Echo, John B. (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). June. 1965. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The ratio of the amount of soluble compound radioisotope used to give a unit amount of radioactivity in the critical organ was compared to the amount of the same isotope in calcined waste needed to give this same value. In laboratory experiments using rabbits of the Dutch variety these ratios were $1/10$, $1/2$, and $2/3$, for cesium-137, strontium-90, and plutonium-238-239, respectively. (auth)

**32468** (NP-15092) CENIZA-ARENA CLEANUP IN SAN JOSE, COSTA RICA: OPERATIONAL ASPECTS AS RELATED TO NUCLEAR WEAPON FALLOUT DECONTAMINATION. Clark, Donald E. Jr.; Lee, Hong (Stanford Research Inst., Menlo Park, Calif.). May 1965. Contract N228-(62479)65421. 56p.

The continuing eruptions of Volcán Irazú and the consequent deposition of volcanic debris on the city of San José, Costa Rica, offered a unique opportunity to study the physical effects of fallout-like particles deposited in urban areas. Detailed records of the particles deposition and removal from San José were tabulated and analyzed. The magnitude and problems of decontaminating a fallout contaminated city were illustrated (except for the complicacy of radiation) in the San José cleanup operations. (auth)

**32469** (ORNL-3820) APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1964. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 85p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The waste gaseous and liquid releases from Oak Ridge National Laboratory were such that the concentration of radioactive materials in the environs were well below the maximum levels recommended by the NCRP and FRC. The average concentration of radioactive materials in the atmosphere at the perimeter of the controlled area was less

than one percent of the maximum permissible. The number of beta curies released via White Oak Creek to the Clinch River was 234, or about half the 1963 release of 469 curies. The average concentration of $^{131}I$ in raw milk samples was 11.4 pc/l or about 12% less than the 1963 value. Background measurements at five selected locations adjacent to the ORNL area decreased by a factor of about two from 1963 to 1964. The average for 1964 was 0.014 mR/hr. No employee received an external or internal radiation dose which exceeded the maximum permissible levels recommended by the FRC. The highest whole body dose equivalent received by an employee was about 4.2 rem or 35 percent of the maximum permissible annual dose. During 1964 there were no cases of internal exposure where the deposition of radioactive materials within the body was estimated to have averaged greater than half of a maximum permissible body burden. During 1964 the frequency of Unusual Occurrences dropped to a five-year low of 29 events. Only about 50 percent of these events were classified as significant according to the ORNL rating of Unusual Occurrences. Revisions in personnel monitoring techniques and development of improved bio-assay procedures resulted in significant cost reduction in these programs during 1964. During 1964, 22 persons from outside the continental United States received training at Applied Health Physics (AHP) facilities. In addition, 130 other persons from within the United States visited AHP for training purposes or to observe AHP activities. (auth)

**32470** (UCRL-7922) HIGH-EXPANSION FOAM FIRE CONTROL SYSTEM FOR GLOVED BOXES. Lindeken, C. L.; Taylor, R. D. (Lawrence Radiation Lab., Univ. of California, Livermore). June 10, 1964. Contract W-7405-eng-48. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A high expansion foam generator designed for the control of gloved box fires is described. Foam is produced at 10 cfm from argon gas and a 1% aqueous solution of ammonium lauryl sulphate. The unit is automatically started when a preset temperature rise is detected inside the box by a thermal switch. Magnesium fires can be controlled and the foam provides sufficient thermal insulation so that combustibles adjacent to the burning metal are not ignited. (auth)

**32471** (FTD-TT-64-1352) HOW TO PROTECT ONESELF AGAINST THE EFFECTS OF ATOMIC WEAPONS. Wiatrowski, Wieslaw. Translated from Przeglad Tech., No. 4, 6-(1964). 6p. CFSTI.

Nuclear explosions are accompanied by shock waves, thermal radiation, intense light, penetrating radiation consisting of neutrons and x radiation, and fallout that results in contamination of the terrain. The probable biological effects of air and ground explosions of atomic and thermonuclear weapons are reviewed. The importance of shelters in protection against the effects of nuclear weapons is stressed. (C.H.)

**32472** THE NEED FOR REGULATIONS AND CODES OF PRACTICE. Thompson, R. A. (Office of the Minister for Science, London). Ann. Occupational Hyg., 7: 5-8 (Jan. 1964).

The need for regulations controlling the use of radiation sources in industry and medicine in the United Kingdom is discussed, and regulations now existing in the U.K. are compared with those in other nations. Accepting the need for control, the question is discussed, when are Regulations appropriate and when is a Code of Practice to be preferred? On the European Continent the value of Codes of Practice is doubted, as was found when the U.K. was negotiating for entry into Euratom. The absence of a strict legal requirement to comply with the provisions of the Codes was regarded as a weakness which might, in some circumstances, prejudice the rights of an individual claiming compensation for radiation injury. Criticism has also been made in the U.K. that the voluntary nature of the requirements of, for example, the Hospitals Code of Practice has the effect that shortage of funds can become the reason for nonobservance of the Code. Another aspect of the controversy is that responsibility in the health and safety fields is the concern of so many government departments in the U.K. Critics have said that there should be one basic law on the subject and have implied that regulations should be the responsibility of one government department, which would act over the whole field under the basic law. However, the appropriate Minister for regulations in respect to the transport of radioactive substances is plainly the Minister of Transport; regulations relating to factories as places in which radioactive substances are used are appropriately the responsibility of the Minister of Labour, who has long been responsible for health and safety matters generally in factories. The alternative would be to set up a Ministry of Atomic Energy which would be responsible for both these functions and all similar regulating functions in the atomic health and safety field. It is considered more appropriate that atomic energy regulation be assimilated into existing fields of activity; as regards transport, the Ministry of Transport should be responsible, as regards factory regulations, the Ministry of Labour, hospitals, the Ministry of Health, and so on. The question is also considered, whether it will ever be possible or necessary to incorporate all existing provisions into a single code? This has been achieved in at least two countries, New Zealand and the Soviet Union. However, it is felt that this way of dealing comprehensively with the problem would not be practicable in highly industrialized countries with large populations, advanced atomic energy programs, and a great proliferation of activities involving the use of ionizing radiations. It is concluded that safety in this field cannot be guaranteed simply by the existence of regulations and codes; there is a continuing need for education and training in protective measures and for the cooperation of all concerned with the use of ionizing radiations if adequate protection is to be ensured at all times. Moreover, radioactive hazards should be kept in perspective. Although it is necessary to take all reasonable precautions, it is also necessary to consider that there may be a point beyond which the expenditure of further effort and money is not only in danger of making atomic energy development uneconomic but is also open to the objection that it may give a poor additional return in comparison with a similar expenditure in other fields where risks are run. (BBB)

**32473** PROTECTION FROM RADIATION. Brit. Med. J., 1: 672-3(Mar. 13, 1965).

Recently developed codes of radioprotective practices in various nations are briefly discussed. One recent survey, prepared by the World Health Organization, summarizes the present control arrangements in 26 countries and shows two different approaches to the problem. In some countries, including Canada, New Zealand, and Norway, the attitude is that radiation hazards are inherently unsuited to detailed legislative control. Consequently the control depends on the voluntary actions of radiation users in accepting the advice offered. Elsewhere, as in Switzerland and Russia, legislation is much more specific, leaving little to be decided by individual users or hospitals. British practice includes both of these philosophies. The strict control in the U. K. over luminizing operations, established in 1947, is being extended by regulations (under the Factories Act) now in force or in preparation. Most of the industrial uses of radiation will soon be dealt with in this way in the U. K. Separate codes of practice have been prepared for radiation workers in hospitals and in research establishments. A newly revised version of the hospital code includes instructions on radiation hazards to patients, disposal of radioactive waste, and safety procedures in dental radiology. Though designed mainly for institutions, the new code is recommended as a guide to all medical and dental practioners in Great Britain. The main emphasis of the code is on safe working habits, reinforced by structural and mechanical protection against radiation and by expert supervision, including medical examination and systematic monitoring of personal radiation doses. Employers must appoint a radiological protection adviser and a medical officer. Departments using radiological equipment or radioactive materials must have a radiological safety of-

ficer to ensure that the prescribed measures for radiation protection are carried out, though responsibility that the code is observed rests with the head of the department. The code of practice also includes sections on the transport of radioactive materials, design of isotope laboratories, clinics, and wards, discharge of patients during treatment with radioactive materials, and a number of technical appendices. (BBB)

**32474** CONGENITAL ABNORMALITIES IN ALBERTA. Newcombe, Howard B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Med. Assoc. J., 89: 625(Sept. 21, 1963).

Criticisms are advanced against the data and conclusions of le Vann (Can. Med. Assoc. J., 89: 120(1963)) indicating a rise in congenital anomalies in the Province of Alberta and attributing this rise to radiation from fallout. It is pointed out that an increase in risk in the northern area of the Province amounting to as much as 30% over that in the southern area, and to 60% when the cities of Edmonton and Lethbridge are compared, is attributed to differences in precipitation and radioactive fallout, without discussing the possible extent of the supposed differences in tissue dose received from the fallout. The average dose to soft tissue from radioactive fallout is known to be roughly two orders of magnitude less than that received from natural sources (i.e., in the vicinity of 1 mrad per year as compared with 100 mrad from nature). Regional variations in this dose probably amount to an even smaller percentage of the total to which persons are exposed by nature. It is supposed, for example, that fallout is proportional to precipitation and that in recent years the average exposure to soft tissue over the whole of the Province of Alberta has included, in addition to the 100 mrad per year from nature, a further 1 mrad from fallout. Since precipitation if 44% heavier in the north than in the south, the contributions from fallout in the two areas would be 0.82 and 1.18 mrad per year. The total exposures, including the contributions from nature, would thus be 100.82 and 101.18 mrad, respectively, a difference of only 0.36%. It is suggested that this does not imply that very low doses have no effect at all, and it is likely even low doses may induce both developmental disorders and malignant changes in embryos. However, to attribute a 30 to 60% difference in incidence of congenital malformations to, at most, a 1% difference in radiation, without discussing possible magnitudes of exposures, seems unjustifiable. (BBB)

**32475** CONGENITAL ABNORMALITIES IN ALBERTA. Williams, N.; Ramsay, J. D. (Dept. of Public Health, Regina, Can.). Can. Med. Assoc. J., 89: 626-7(Sept. 21, 1963).

Objections are raised to the conclusions of le Vann, appearing under the title Congenital Abnormalities in Children Born in Alberta during 1961: A Survey and a Hypothesis, (Can. Med. Assoc. J., 89: 120(1963)). This article attributed the purported higher incidence of congenital anomalies in the northern, as compared with the southern, part of Alberta Province to greater rainfall and thence higher fallout levels. The present authors point out that published reports of the Radiation Protection Division of the Department of National Health and Welfare show that more rain falls on Edmonton than Calgary, ipso facto more radioactive fallout is deposited on Edmonton than Calgary. Mean air fallout in disintegrations per $m^3$/min and precipitation fallout in $mC/mi^2$ for Calgary and Edmonton for 1960 and the first eight months of 1961 (the levels in the last four months would not have influenced the incidence of congenital abnormalities of children born during 1961) reveal that there is no significant difference between the fallout present in the air or the amount of fallout deposited by precipitation per $mi^2$. The radiation dose received by the public from such fallout during the period given above would be only a fraction of that received from natural background radiation. In response to the article a spokesman for the U. S. Public Health Service pointed out that fallout from atomic weapons already tested was considered to produce only a few thousand congenital abnormalities in the next few generations. Amended data are reported for the rate of congenital anomalies in Alberta, which show a figure of 7.58 per thousand births, a lower rate than that published in the original report. It is concluded that there are no valid data attributing congenital anomalies in Alberta to fallout. (BBB)

**32476** RADIATION PROTECTION. Rodale, Robert (Health Bulletin, Emmaus, Penna.). Can. Med. Assoc. J., 92: 1039(May 8, 1965).

It is pointed out that F. D. Sowby overlooked an important consideration in his article "Radiation Protection in Canada. Part VII. Setting Standards for Radiation Protection" (Can. Med. Assoc. J., 92: 505(Mar. 6, 1965)). In discussing the risks associated with almost any man-made invention, he neglected to draw a distinction between those risks which are completely or partially avoidable by careful people, and those risks which no one can escape. Attention is called particularly to his comment: "If, in Canada, society is prepared to tolerate, however reluctantly, some 4000 deaths annually from motor vehicle accidents, and an even larger number due to cigarette smoking, how many would it consider to be a tolerable price to pay for the advantage of having a nuclear energy program, extensive facilities for medical radiology, and widespread uses of radioisotopes?" That sentence leads one to conclude that Sowby feels that the risks of motor vehicle accidents and cigarette smoking are largely comparable with the risks of radiation. That is not so, because a person can choose to avoid the cigarette habit completely. He can also use reasonable and practical measures to reduce his risk of motor vehicle accident. However, the risk of radiation strikes all people equally. The only exception might be those people, such as the very young and the Eskimos, whose situation in life unavoidably exposes them to larger radiation risks. It is concluded that a deeper philosophical analysis must be made of the risks of man-made inventions to set much stronger standards of protection for those side-effects of technology which are inescapable. (BBB)

**32477** THE RADIOACTIVITY OF SOME CZECHOSLOVAK WATERS. Havlik, B. Cesk. Hyg., 9: 551-64(1964).

The natural radioactivity with a special regard to $^{226}Ra$ and $^{40}K$ contents, the total beta-radioactivity of water, sediments and biological materials was studied in six rivers, six creeks, one reservoir and two ponds. Biologic material, water samples, and sediment samples were analyzed. The total beta-activity of surface waters studied was 1 to 96 pc per liter (average 43 pc per liter), 1000 to 274,000 pc/kg of wet sediment in sediments (average 24400 pc/kg), and 200 to 98400 pc/kg of living substances in biologic material (average 20300 pc/kg). The activity caused by $^{40}K$ was 8 to 13 pc per liter (average 6 pc per liter) in water, 300 to 6800 pc/kg of wet weight in sediments (average 2100 pc/kg), and 100-10,000 pc/kg of living substance in biologic material. The $^{40}K$-total beta-activity ratio was 25% in water, 10% in biologic material and 7% in sediments. The $^{226}Ra$ content was 0.1-7.9 pc per liter (average 1.0 pc per liter) in water, 10 to 960 pc/kg of wet sediment (average 262 pc/kg) in sediments and 1-950 pc/kg of living substance (average 148 pc/kg) in biological material. Results are compared with published data. (Exerpta Med., Sect. XXIII, 2: No. 4(Apr. 1965))

**32478** DEVELOPMENT AND CURRENT ASPECTS OF HOT LABORATORIES. Energie Nucl., 7: 38-44(Jan.-Feb. 1965). (In French)

Hot laboratories, which have various functions, have in common a certain number of essential characteristics, based principally on the necessity of protecting the operators against radioactivity and on the rigorous working conditions that the materials manipulated require. The problems faced by the installer of hot laboratories are summarized. Some recent developments and various types of apparatus, already known or adapted for work in hot cells, are briefly described. A survey is given of the role that can be assigned to an engineering society in the realization of these types of installations. (tr-auth)

**32479** AEROSOL PENETRATION THROUGH PINHOLED FILTERS. Thomas, Jess W. (Atomic Energy Commission, New York). Health Phys., 11: 667-73(July 1965).

A theory of penetration of aerosols through filters with pinholes has been developed, which predicts increasing aerosol penetration with decreasing flowrate through the pinholed filter. Tests showed fair agreement with theory for a relatively large pinhole, but deviations from the theory increased as the pinhole size became smaller. Penetration through pinholes was found to be little affected by particle size, which indicates that in testing filter installations for leaks (in-place filter testing), aerosol particle size is much less important than in evaluating intact filter media. (auth)

**32480** LEGAL LIABILITY FOR GENETIC INJURIES FROM RADIATION. Estep, Samuel D. (Univ. of Michigan, Ann Arbor); Forgotson, Edward H. Louisiana Law Rev., 24: 1-53(Dec. 1963).

An analysis is made of the legal significance of genetic effects of human exposure to ionizing radiation. As an example, the problem is discussed as to whether birth of a mongoloid child to the wife of the victim of an accidental exposure to ionizing radiation five years earlier may be the basis of recovery of legal damages. Primarily because of the difficult proof problems involved in genetic damage cases, it is suggested that unacceptably inequitable results will be reached if traditional methods of dealing with such personal injury cases are used. The legal consequences of possible genetic injury from radiation are examined in terms of the difference between low level occupational exposures and accidental acute and fairly high level exposures of an individual. Based on the reasoning and assumptions presented, it is stated that if a given individual receives a preconception gonadal dose of radiation short of that which approximates the mid-lethal dose in humans, it is highly improbable that the individual will have a defective first generation child whose defects could be attributable to that dose. Therefore, under existing rules concerning proof of causation, no recoveries should be permitted for possible future manifestations of genetic damage. A contingent injury fund concept is proposed, which charges defendants at time of exposure but provides for compensation of exposed persons only when and if the injury manifests itself, as the only equitable means of dealing with such injuries. Even though the linear theory of radiation mutation production is accepted, for legal purposes a radiation exposure cut-off point should be established. The doses of 50 Rad for instantaneous or acute exposures and 200 rad for long-term or chronic exposures are suggested as a cut-off point below which any exposures to a given individual should be regarded as statistically insignificant in specifically increasing the likelihood of an offspring in any subsequent generation bearing a harmful hereditary defect above the expected incidence of such defects resulting from spontaneous mutations or induced mutations caused by exposure to other potential mutagens. (TCO)

**32481** INVESTIGATIONS UPON POSSIBLE CONSEQUENCES OF LOCAL RADIOACTIVITY IN CORNWALL. PARTS I AND II. Willey, E. J. B. Med. Officer, 112: 130-3(1964).

Evidence is presented to show that not only is there no definite evidence that can connect any apparently abnormal incidence of leukemia with background beta-gamma radiation of magnitude greater than usual, but also that families have for considerable periods lived in regions of exceptionally high background and enjoyed good health. Examination of blood samples taken from leukemic patients showed no beta-gamma radioactivity apart from that due to the potassium content. Similarly, there was no perceptible difference between activities of normal bloods taken from high and low background regions of England. In one small group of patients it was found that therapeutic irradiation for treatment of leukemia was followed by a release of potassium into the blood and hence the inception of a higher degree of radioactivity than existed before this treatment. One sample of a pleural effusion from a case of lymphosarcoma gave an activity some 2½ times as great as could be accounted for on the basis of emanations from potassium. It is generally concluded that there is no correlation between local radioactivity at levels up to 10 times the national average and the local incidence of leukemia, and that neither leukemic nor healthy individuals from any locality show evidence of body absorption of active materials of local derivation. Vegetation of various kinds was examined from ground where considerable gamma activity due to radium was found. In no case has any abnormality in structural features, or appreciable absorption of radium into the plants been found, even with backgrounds equivalent to 25 mR/hr. In many instances, the ashes of the plants were noticeably active, this being, however, due to substances which answer to tests for the radiostrontiums, plus normal potassium. These tests have been confirmed by chemical examination. The overall activity of the ash appears to bear no relation to the gamma activity of the ground, a high figure in one case often accompanying a low figure in the other, or vice versa. (Excerpta Med., Sect. XXIII, 2: No. 4,(Apr. 1965))

**32482** CONSIDERATION OF LATE URANIUM INJURIES AND EVALUATION OF CERTAIN EXPERIMENTAL RESULTS. Zahnert, R.; Dannecker, A.; Poetschke, H. (Versorgungsaerztliche Untersuchungsstelle Stuttgart des LVA, Baden-Wuerttemberg, Ger.). Med. Sachverstaend., 59: 151-5(Aug. 1963).

Comparison of air concentrations of Rn radioactivity shows that the values in the uranium mines of the Joachimsthal area are in the same range of concentration as those of the mines in Utah. Ventilation reduces the air concentration. The variety of working conditions makes it difficult to evaluate irradiation effects from these concentrations of radioactivity. Miners sometimes work from 8 to 10 hr daily for 300 days per yr. Ra concentations were studied in miners who had worked from 21600 to 40500 hr in the Joachimsthal mines, and who had been retired for 1 to 11 yr before death. Their lungs contained between 4.9 and $18.2 \times 10^{-14}$ g/g tissue of Ra. The concentration of Ra in vertebrae was from 290 to $534 \times 10^{-14}$ g/g tissue. There was no direct relation between age and Ra concentrations. Also, there was no direct relation to hr worked in U mines, or the number of yr retired and away from the mines. The Ra concentration differed considerably between the lungs and the vertebrae in all individuals, and no trend could be ascertained. (BBB)

**32483** DISTRIBUTION OF RADIOCARBON FROM NUCLEAR TESTS. Nydal, Reidar; Loevseth, Knut (Norwegian Inst. of Tech., Trondheim). Nature, 206: 1029-31(June 5, 1965).

Measurements of $^{14}C$ produced during the thermonuclear tests in 1961 and 1962 are discussed. Carbon-14 concentrations were determined in milk, beef, and human blood. A definite increase in body burden was verified in the Norwegian population. It was concluded that human $^{14}C$ burdens were directly proportional to fish consumption. Tropospheric activity was determined at ground level on various latitudes from 9°N to 78°N. (H.G.D.)

**32484** DISTRIBUTION OF STRONTIUM-90 IN SURFACE AIR DURING 1963. Volchok, H. L. (Atomic Energy Commission, New York). Nature, 206: 1031-3 (June 5, 1965).

Data on $^{90}Sr$ distribution in ground-level air collected by the Health and Safety Laboratory of the USAEC during 1963 is discussed. Strontium-90 fallout did not exhibit seasonal fluctuations in the Southern Hemisphere as well defined as those in the Northern Hemisphere, due to the relative concentrations in the air in the two hemispheres and to the timing of air movements in the troposphere. Ratios of $^{89}Sr$ and $^{90}Sr$ are also presented. (H.G.D.)

**32485** CHANGES IN HUMAN BODY BURDENS OF GAMMA RADIOACTIVITIES, 1960-64. MacDonald, N. S.; Hepler, M.; James, E.; Hamel, R.; Darnell, T.; Steen, A. J. (Univ. of California, Los Angeles). Nature, 206: 1127-8(June 12, 1965).

The results of 480 measurements of whole-body gamma activity in 218 individuals living in or near Los Angeles, California, during the years 1960 to 1964 are presented. $^{40}K$ and $^{137}Cs$ were identified in all subjects. The observed contents of $^{137}Cs$ were plotted as pC per gram of potassium. No other gamma activities were observed in significant amounts. Some subjects exhibited a relatively constant $^{137}Cs$ concentration from 1960 until the last quarter of 1963, when a significant increase was observed. The rates of radiation dosage from a constant body burden of 95 pC $^{137}Cs$/gK and 130 gK were estimated as 1.4 and 17.6 mrem/yr, respectively. (M.C.G.)

**32486** RADIOACTIVE MATERIALS IN PHARMACY. IV. PROTECTION AGAINST THE HARMFUL EFFECTS OF IONIZING RADIATION. Spaander, P. (Rijks Instituut voor de Volksgezondheid, Utrecht). Pharm. Weekblad, 98: 1098-1106(Nov. 22, 1963). (In Dutch)

The protection regulations of the Internation Commission on Radiological Protection are reviewed. Radiation levels permitted for radiological workers are given for the whole body and for various organs. Likewise permissible amounts for other workers and inhabitants in the vicinity of points of utilization of isotopes are given. Internal irradiation is discussed with definition of maximum permissible concentrations in water. The consumption and release of water by the standard man are outlined, and a note on critical organs follows. The factors which influence the distribution of isotopes in the body are mentioned. The importance of half lives in this connection is emphasized, with particular note on $^{137}Cs$ and $^{90}Sr$. Radiation doses and calculations of maximum allowable concentration in drinking water are considered. For the general population, the sources of radiation are enumerated and the I.R.C.P. values are given. Finally, desirable limits for radioactive exposure are given. In the Benelux countries the formula for the general population is: $5(\alpha) + \beta + 500(^{226}Ra) + 30(^{90}Sr) \leq 1000$ pC/l. Values are lower than the I.C.R.P. recommendations, since these were originally recommended as maximum values. Practical procedures for ensuring safety are briefly discussed. (BBB)

**32487** RADIOACTIVE MATERIALS IN PHARMACY. V. LEGAL REGULATIONS. Spaander, P. (Rijks Instituut voor de Volksgezondheid, Utrecht). Pharm. Weekblad, 98: 1137-46(Dec. 6, 1963). (In Dutch)

The legal foundation of regulations governing the use of radioactive isotopes and related materials in the Netherlands is briefly reviewed. Particular attention is directed to the pharmacist and the administration of radioactive materials to patients. A set of examples illustrating mathematical calculations for practical examples is given in this connection. The following standards taken from the American Pharmacopoeia (16th edition) are given: $^{32}P$–sodium radiophosphate solution; $^{51}Cr$–sodium radiochromate injection; $^{60}Co$–radiocyanocobalamin solution; $^{131}I$–radioiodinated serum albumin, sodium radioiodide capsules, sodium radioiodide solution; $^{198}Au$–radiogold solution. The preparation of the nuclides and preparation of the compound for medical use is listed, together with the doses for diagnostic and therapeutic uses where applicable. For the I compounds, special mention is made for methods of measuring the radioactivity of samples. (BBB)

**32488** MEASUREMENT OF ATMOSPHERIC RADIOACTIVITY IN THE ENVIRONMENTS OF LUCHON. Arnaud, Y.; Grandpierre, R.; Moroni, J. P. Presse Thermale Climat., 101: 65-6(1964).

A study was made of the thermal bath radioactivity at Luchon in the French Pyrenees. It is pointed out that the radioactivity in the valley is mainly determined by the concentration of radon in the air, whereas in the higher regions, where much rain falls throughout the year, the main radioactivity is from fallout. Therefore the concentration of fission products in the milk is higher in high regions than in valleys and higher in the Pyrenees, where rainfall is considerable, than in the Alps. All values are below the maximum permissible, however. (Excerpta Med., Sect. XXIII, 2: No. 4, (Apr. 1965))

**32489** LAW AND ADMINISTRATION. VOLUME 3. NUCLEAR LIABILITY. Weinstein, Jerry L. (ed.). A Pergamon Press Book. Progr. Nucl. Energy, Ser. X, 3: 1-483(1962).

The legal consequences of personal injury or property damage resulting from a nuclear incident are discussed. The reasons why the dual test of reasonable and adequate compensation for the public and tolerable conditions for the development of the nuclear industry cannot be satisfactorily met under existing tort rules are considered, along with the choices made and the ways in which the different sets of interests involved were adjusted and balanced. Topics covered include: adaptation or revolution, liability without fault, U. S. Atomic Energy Commission licensing, state control and liability in the nuclear industry, concepts and procedures in safety evaluation and licensing, review of nuclear incidents, third party liability of suppliers in international nuclear transactions, liability for the transport of radioactive materials, the role of insurance, some preliminary reflections on the international responsibility of states, indemnification against liability for nuclear incidents in licensed atomic energy activities, indemnification of the USAEC's contractors against liability for nuclear incidents, liability legislation in the Federal Republic of Germany, United Kingdom legislation, problems of international legislation regulating the liability of operators of nuclear ships. (M.C.G.)

**32490** IODINE-131 FALLOUT FROM UNDERGROUND TESTS II. Martell, E. A. (National Center for Atmospheric Research, Boulder, Colo.). Science, 148: 1756-7(June 25, 1965).

Probable sources for the repeated occurrences of $^{131}I$ fallout in midwestern U. S. during May 1962 are discussed. It is clearly indicated that vented underground tests in Nevada cannot be discounted as the source in favor of precipitation scavenging of a stratospheric source of debris by thunderstorms that penetrate into the stratosphere. (P.C.H.)

**32491** THE NEW LEGAL REGULATIONS FOR RADIATION PROTECTION IN MEDICINE. Minder, W. (Radiuminstitut, Bern). Therapau. Umsch., 21: 51-6(Feb. 1964). (In German)

The author reviews the regulations that came into effect in 1963 for the use of x irradiation in medical diagnosis. These laws affect all x-ray installations, including therapeutic and diagnostic applications of radioactive materials, or wherever ionizing radiations may be used. The regulations establish a genetic tolerance dose of 5 rem per 30 yr. In Switzerland the average exposure of the population to external irradiation is 0.122 R per yr, and 97% of children are born to mothers 30 yr old or less. Usually the gonadal dose received during x-ray photography or fluoroscopy can be reduced to 10% or less of its value by use of very simple measures. At the same time the diagnostic quality can be improved. The field size should be reduced as much as possible to approximate the size of the object to be studied. In many cases, such as in photographs of the gastrointestinal tract, kidneys, spinal column, hip joint, femur, or lung, the gonads can be shielded very effectively by use of a Pb apron or plate. In dental photographs of the upper jaw, when the irradiation is directed in the downward direction, protection of the gonads by Pb shielding is absolutely required. If the gonads are unavoidably included within the irradiation beam, use of hard radiation will reduce the gonadal dose to less than half of its value. The general purpose of the new regulations is twofold. One purpose is to establish working limits for personnel engaged in radiation work, and the other is to protect the remainder of the population. (BBB)

**32492** THE EFFECT OF RADIATION SICKNESS ON THE PROGRESS AND TREATMENT OF MECHANICAL AND THERMAL INJURIES. Schumacher, K. (Ernst-Moritz-Arndt Universitat, Greifswald, Ger.). Z. Aerztl. Fortbild. (Jena), 58: 396-402(Apr. 1, 1964). (In German)

It has been estimated that 70 or 75% of persons exposed

to atomic weapons would suffer mechanical and thermal injuries, and that 30% receive radiation injuries. Of the total persons injured, 75% would suffer combinations of these injuries. As a result the various injurious agents, complexes of injury conditions, would be observed. These include leukopenia and impaired resistance to infection, shortened delay in appearance of irradiation symptoms, intensified evidence of shock, and an increased tendency toward hemorrhage, with increased sensitivity to blood loss. The author discusses a wide range of general and specific medical procedures and drugs that can be used to treat and support recovery of persons with combined radiation and mechanical or thermal injuries. Some general treatment procedures include absolute isolation and rest, special dietetic supplementation, strict medical supervision to prevent acute hemorrhage or circulatory failure, and parenteral administration of fluids. Other special measures include treatment of the primary reactions to injury by antihistamines, sedatives, antibiotics, hormones, support of circulation, blood transfusions, etc. (BBB)

**32493** FOTOGRAFICHESKAYA DOZIMETRIYA IONIZIRUYUSHCHIKH IZLUCHENII. (Photographic Dosimetry of Ionizing Radiation). Kozlov, V. F. Moscow, Atomizdat, 1964. 156p.

A brief review is given of photographic methods used in ionizing radiation dosimetry. Applications of photographic processes in personnel monitoring are discussed. 118 references. (R.V.J.)

**32494** NORME PER IL TRASPORTO DI MATERIALE RADIOATTIVO. (Standards for the Transport of Radioactive Materials). Rome, Comitato Nazionale Energia Nucleare, 1963. 146p.

The book is divided into three sections. The first part (Regulations for the Transport of Radioactive Materials) is the Italian version of STI/PUB/40 NSA 15: 23800). The third part (Standards for Protection Against Radiations During the Transport of Irradiated Fuel Elements) is the AEC Regulation 10 CFR, Part 72. The second part concerns international regulations for the transportation of radioactive materials by rail. The classification of radioactive materials is given and the conditions for the transportation with regard to the packing, method of transport, bill of lading, transportation materials, prohibitions, and warning lettering are reported. (J.S.R.)

**32495** NUCLEAR SAFETY. Volume 6, Number 3. Cottrell, William B., ed. (Oak Ridge National Lab., Tenn.). Spring 1965. $0.70(GPO) (domestic), $0.90 (GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 90p. Dep.

An article on safety-system design technology is presented along with a book review on reactor physics and control. Other information is included on radiation protection in space, transportation of irradiated fuel elements, status of SPERT, fast reactor safety problems, testing of rock for underground reactor containment, removal of radioiodine from gases, waste disposal from U mills and mines, fallout from nuclear weapons, Indian Point power station operating experience, nuclear accident at Wood River Junction R.I., regulatory action on reactor projects, and changes in reactor licensing regulations. (J.R.D.)

**32496** REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. 1964 Revised Edition. (International Atomic Energy Agency, Vienna (Austria)). Safety Series No. 6. 1965. 113p. (STI/PUB/97). $2.50 S 52,50 (15/-stg; F.Fr. 10,-; DM 8,-) IAEA.

Safety regulations are given for the national and international transport of radioactive materials by all means of transport. The regulations are arranged into five parts which deal with general provisions; materials, instruments and articles exempted from the third and fourth parts; packaging and delivery of packages to transport; storage and carriage; and labels and placards. Appendices giving packaging regulations for fissile and nonfissile materials and test procedures, are also included. (D.L.C.)

**32497** DUST CONTROL AND AIR CLEANING. Proceedings of the Symposium Arranged by the Process Engineering Group of the Institution of Mechanical Engineers, 4th April 1963. London, Institution of Mechanical Engineers, 1964. 67p. (CONF-630407)

A separate abstract was prepared for one paper. Other papers discuss the sampling and filtration of airborne particles, air cleaning equipment, dust control in the textile and pottery industries, and air cleaning and sterilization in biochemical laboratories. (C.H.)

*For an abstract of the individual paper see: 32498.*

**32498** AIR FILTRATION IN THE PROCESSING OF TOXIC METALS. Sunderland, A. (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). p.25-31 of "Dust Control and Air Cleaning." London, Institution of Mechanical Engineers, 1964.

Hazards involved in handling Be and Pu in powder form are reviewed. It is concluded that it is possible to process on a production scale materials as toxic as Be and Pu with safety, provided that the plant is well designed, the operational housekeeping is good, and most important, that there is an adequate and efficient air extraction and filtration system. The cost of plants which meet the requirements of containment, criticality, ventilation and filtration is much higher than the cost of similar plants processing nontoxic or non-fissile materials. A significant item in the total capital cost is the ventilation and filtration equipment. In the cases considered this amounted to between 10 and 15 per cent of the total cost of the project. (C.H.)

**32499** SLIDE-RULE FOR PERFORMING CALCULATION INVOLVING SCREENS TO PROTECT PERSONNEL AGAINST RADIATIONS. Lavie, Jean-Marie (to Commissariat a l'Energie Atomique). U. S. Patent 3,162,363. Dec. 22, 1964. Priority date Sept. 9, 1958, France.

A slide rule is described that is usable for calculations that involve five variables relating to screen protection for personnel. The five variables are activity of source, distance of the source from the operator, thickness of the screen, energy of a unit flux of photons, and intensity of the radiation. If any four of the variables are known, the slide rule makes it possible to determine the fifth. The rule includes a base, a movable slider, and a transparent cursor on the base. The rule may be used for finding the total effective macroscopic cross section of various materials, direct reading of the equivalent thickness of lead for different materials in function of energy, and solving protection problems for non-point sources. (B.L.M.)

**32500** CONTAINER FOR RADIOACTIVE MATERIALS. Aupetit, Armand; Blum, Paul; Jouin, Jacques (to Commissariat a l'Energie Atomique). U. S. Patent 3,175,087. Mar. 23, 1965. Priority date July 6, 1960, France.

A container adapted for transporting cartridges of fissile material is made up of two stainless steel chambers with lead filling the space between them. The outer chamber is equipped with cooling fins and devices for handling and securing purposes. A cartridge carrier basket fits inside the inner chamber. Plugs for each chamber provide a double fluid-tight seal and radiation shielding. The container is loaded in a bath and is provided with an exhausting device. (A.G.W.)

# INSTRUMENTATION

## General

*Refer also to abstracts 32253, 32680, 32811, and 32843.*

**32501** (AD-608498) ALPHA RADIATION HYGROMETER. VOLUME I. AUTOMATIC FROST-POINT HYGROMETER FOR STRATOSPHERIC WATER-VAPOR MEASUREMENTS. Final Report. Ballinger, J. G.; Kirvida, L.; Fricke, M. P.; Crowley, J. E. (Honeywell, Inc., Minneapolis, Minn. Aeronautical Div.). Aug. 15, 1964. Contract AF19(604)-8418. 53p. (AFCRL-64-690(I)). $3.00(CFSTI).

A new type of automatic frost-point hygrometer is described for measurement of the atmospheric distribution of water vapor. The mass of the frost deposit on a cooled surface is detected directly by energy attenuation of alpha radiation. An automatic control maintains a constant amount of this frost by controlling the direction of current flow through a thermoelectric cooler. The instrumentation of this hygrometer is described in some detail, and balloon-flight tests of prototype units are presented. (auth)

**32502** (AD-609977) THERMODYNAMIC METHODS OF HIGH-TEMPERATURE MEASUREMENT. Grey, Jerry (Princeton Univ., N. J.). Oct. 1964. Contract AF33(657)-9926. 64p. (ARL-64-179). $3.00(CFSTI).

Thermodynamic temperature measurement techniques fall into three separate classes: pneumatic devices, heat-transfer gages, and calorimetric methods. All three are characterized by the ability to measure temperatures (or related fluid properties such as enthalpy) at levels beyond the capability of thermoelectric materials or pyrometer calibration devices. This report reviews the principle of operation, present status, range of applicability, and performance of each of these thermodynamic temperature and enthalpy-measuring techniques. In many instances, particularly when opaque gases or high temperature gradients are present, the thermodynamic probes represent the only suitable method for measurement of extremely high gas enthalpies and temperatures. (CFSTI)

**32503** (CEA-R-2783) APPAREIL DE MESURE DU POUVOIR THERMOELECTRIQUE ET DE LA RESISTIVITE A HAUTE TEMPERATURE — RESULTATS SUR LE FER ARMCO. (Apparatus for Measuring Thermoelectric Power and High-Temperature Resistivity — Results Concerning Armco Iron). Vandevyver, Michel; Borde, Dominique; Albany, Halim-J. (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Apr. 1965. 11p. Dep.(mn).

A description is given of an apparatus for the simultaneous measurement of thermoelectric power and electric resistivity of thermoelements between 50°C and 1000°C. (auth)

**32504** (NRL-6236) A STUDY OF THE INSTABILITY OF NOBLE METAL THERMOCOUPLES IN VACUUM. Walker, B. E.; Ewing, C. T.; Miller, R. R. (Naval Research Lab., Washington, D. C.). Dec. 12, 1964. 12p. CFSTI.

Thermoelectric instabilities of noble metal thermocouples and individual thermoelements (platinum, rhodium, iridium, and platinum–rhodium and iridium–rhodium alloys) have been studied in vacuum in the temperature range 800 to 1600°C. These studies are an extension of previous work performed in oxidizing and neutral atmospheres. As in that work, the principal source of instability was found to be contamination of the thermoelements by iron impurities from ceramic protection tubes. Iron contamination had a maximum effect on instability in Pt and the alloys but was less important for Ir and Rh. Thermocouple errors associated with this contamination in vacuum were compared with the previous data in air and argon, and the instabilities in vacuum were found to be comparable with those found in argon. The instabilities found for couples in argon and vacuum environments were of much greater magnitude than those found in air. Criteria are set forth for the use of noble element thermocouples. Important among these are the use of low-iron-content sheathing and large-diameter elements. (auth)

**32505** (ORNL-P-160) MODIFICATION OF A 400-CHANNEL PULSE-HEIGHT ANALYZER TO ELIMINATE STORAGE OF PULSES HAVING ENERGIES BELOW A PRESET BIAS. Todd, H. A.; Love, T. A. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Pulses having energies below the preset low-energy cutoff bias of a 400-channel pulse-height analyzer are found to be counted by the analyzer, at a rate proportional to their occurrence probability. This undesirable counting is attributed to the following sequence of events: the trigger opens the linear gate ~2 μsec before the concurrent signal reaches the gate; a pulse arriving at the linear gate during this 2-μsec period is stretched; a signal is thereby applied to the shaping circuits; and the linear gate is thus closed before the desired signal has reached it. The pulse-height analyzer is modified to overcome this difficulty. The modified analyzer operates adequately in tests at 300 to 12,000 counts/sec. (T.F.H.)

**32506** (RT/EL(64)-10) FORMATORE TRANSISTORIZZATO DI IMPULSI A LUNGA DURATA. (Transistorized Generator for Pulses of Long Width). Quaranta, A. Alberigi; Battiston, C. (Bologna Univ. (Italy). Istituto di Fisica). Sept. 1964. 26p. (Dep.(mn).

The classical saturable transistorized univibrator is first studied theoretically and experimentally for use to obtain output pulses from the circuit with width greater than 0.1 sec. Two univibrator circuits capable of supplying pulses with width T = 1.3 sec are described, and the performances are reported. (auth)

**32507** (UCRL-14210-T) THE STABILITY OF AVALANCHE TRANSISTORS. Allen, Philip E. (Lawrence Radiation Lab., Univ. of California, Livermore). [1965]. Contract W-7405-eng-48. 65p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The stability of avalanche transistors is analyzed. This type of transistor is studied in order to improve understanding of the physical phenomena involved in its operation, in order to make possible the use of the device to its optimum capability. (T.F.H.)

**32508** (ORNL-tr-573) THE ELECTRONIC POTENTIOSTAT AND ITS USE FOR THE INVESTIGATION OF RAPID ELECTRODE REACTIONS. Gerischer, Heinz; Staubach, Karl Eberhard. Translated by Myron T. Kelley from Z. Elektrochem., 61: 789-94(1957). 21p. (Includes original, 6p.). Dep.(mn); $2.60(fs), $0.83(mf) JCL.

A potentiostat is a regulating apparatus for the production of a constant potential difference on a regulated circuit. The construction principles and the goal of application of potentiostats for the investigation of electrode reactions is discussed. The course of reaction under potentiostatic conditions is characterized. The reaction of the electrolysis cell on such a regulating circuit is discussed and also the difficulties and problems produced by that reaction. (auth)

**32509** COMPUTATION OF RELATIVISTIC BEAM-WAVE INTERACTION FROM FIELD THEORY. Paschke, Fritz (Siemens and Halske AG, Munich). Arch. Elek. Uebertrag., 18: 105-8(Feb. 1964).

The relativistic beam-wave interaction is analyzed on the basis of a planar model, the circuit field of which degenerates into a TEM-mode with zero longitudinal electric field as the phase velocity approaches the velocity of light. (D.C.W.)

**32510** EXPERIMENTAL SENSITIVITY STUDY OF A 9-GHz ELECTRON PARAMAGNETIC RESONANCE SPECTROMETER. Buckmaster, H. A.; Dering, J. C. (Univ. of Alberta, Calgary). Can. J. Phys., 43: 1088-98(June 1965).

The sensitivity of a 9-BHz magnetic field modulation, homodyne, electron paramagnetic resonance (EPR) spectrometer was calculated as a function of the modulation frequency in the range 10 to $10^4$ Hz from the measured frequency dependence of the parameters describing a selected matched pair of 1N23WE silicon point-contact crystal mixers. The calculated sensitivity was verified to within 3 dB by direct measurement of the signal-to-noise ratio of samples of a free radical (DPPH) containing a known number of unpaired spins in an EPR spectrometer employing the same crystal mixers. Data are also presented to show that the use of modulation frequencies in excess of 0.2 MHz does not result in improved sensitivity if modern crystal mixers are employed. (auth)

**32511** A CRYOGENIC SYSTEM FOR FIELD EMISSION MICROSCOPY IN A MAGNETIC FIELD. Hardin, W. R.; Blair, J. C.; Einspruch, G. Cryogenics, 5: 138-40(June 1965).

A field emission microscope constructed for use in an investigation of the influence of magnetic fields on the emission process is described. The microscope is installed in a liquid helium vessel which incorporates a radiation shield cooled by heat exchange which the cold gases evolved by the liquid. The cryogenic environment serves to cool the field emitter into the temperature range required in the experiment, to permit operation of a superconducting magnet, and to cryopump the experimental chamber to the ultrahigh vacuum required in the experiment. Observations of a focusing effect on the field emitted electrons from tungsten are also presented. (auth)

**32512** THERMOCOUPLES FOR MEASURING HIGH TEMPERATURES. Stadnyk, B. I.; Samsonov, G. V. (Termopribor Design Organization and Inst. of Materials Science, Academy of Sciences, Ukrainian SSR). High Temp. (USSR) (English Transl.), 2: 573-83(July-Aug. 1964). Translated from Tepolfiz. Vysokikh Temp., 2: 634-47(July-Aug. 1964).

A review on the accuracy, limits of application, and reproducibility of existing metal thermocouples is presented. Some data on protective insulation and on the most promising types of thermocouples are included. 57 references. (D.C.W.)

**32513** EMISSION MECHANISM OF OXIDE CATHODE IN THE THERMIONIC EMISSION MICROSCOPE. Sandor, Aurelius (Phylectron Lab., Montreal). Intern J. Electron. (1), 18: 349-68(Apr. 1965).

Photographic recording of emission processes is intended from the 21 in. screen of a thermionic emission microscope. With a triple-carbonate coating on a passive ultra-pure nickel base activation is left to temperature effects and electrolysis. The high field adds a significant component, so that with only 635°C ample beam current is emitted for a 21 in. diameter image display. Conglomerations of triple-oxide crystallites of an average diameter of 3μ represent the individual emission sites with the larger particles always producing higher intensities because of their larger activator reservoir. A quasi layerwise particle emission was found to prevail consisting of a maximum of three layers, each becoming successively prominent with increasing field and/or temperature, until they emit in unison at 705°C. This is explained by potential-shielding of top layers bridging voids and blocking field penetration. Emission, then, consists of progressively decreasing space-charge-limited contributions from each layer with superimposed field components. Electrons never come from lower layers of the oxide bulk to pass through spacings between the well-defined emitting particles of the three upper layers. Hot-point formation is the result of a feedback reaction at sharp surface protrusions between emission, temperature and resistance which may lead to deactivation. Smaller particle size and denser packing appears to circumvent it by equalizing the field. Micropatchiness of emission due to voids is typical. At 735°C emission doubled by electrolytic activation to reach 72 mamp/$cm^2$. Its perfect reversibility points to diffusion of Ba/Sr to the particle surface when heated, while cooling causes back-diffusion. Emission characteristic follows closely the theoretical prediction for combined thermionic and field emission. Extrapolation suggests a yield of 3 amp/$cm^2$ at 782°C and probably higher with increasing temperature. In a non-baked envelope 840°C indicates the borderline between steadily decaying and stable emission attributable to temperature-selective absorption and desorption of residual gases by Ba/Sr. (auth)

**32514** A NOVEL FORM OF X-RAY DIFFRACTION MICROBEAM CAMERA. Oron, M.; Minkoff, I. (Israel Inst. of Tech., Haifa). J. Sci. Instr., 42: 337-8(May 1965).

A description is given of a microbeam camera employing a conical film for back reflection. Diffraction angles and angular spacing between diffraction spots may be easily and accurately measured, and a large amount of data may be recorded on a small conical film with reduced exposure times. An advantage of the camera is the reduction of geometrical distortion in the shape of diffraction spots. The instrument was employed for structural studies of graphite crystals. (auth)

**32515** A 300 Mc/s ELECTRON SPIN RESONANCE SPECTROMETER. Duncan, W.; Schneider, E. E. (Durham Univ., Eng.). J. Sci. Instr., 42: 395-8(June 1965).

An electron spin resonance spectrometer operating at 300 Mc/s is described which uses coaxial line circuitry, including a hybrid ring, and superheterodyne detection with an intermediate frequency of 10.7 Mc/s. The frequency of the signal oscillator is stabilized to the sample cavity using two feedback loops in parallel, acting on electromechanical and electronic tuning devices. In this way, a large hold-in range is achieved as well as a sufficient reduction in the frequency noise of the oscillator. The sensitivity corresponds to $2 \times 10^{14}$ spins per gauss linewidth for a power of 1 mw incident on the cavity and a recorder integrating time of 1 sec. The usefulness of the instrument is demonstrated by a brief description of some applications such as resonances with low g factor and resonances in materials possessing high dielectric or conduction losses. (auth)

**32516** A TRANSISTOR AMPLIFIER FOR REGISTRATION OF THE LOW CURRENT PART OF A LANGMUIR PROBE CHARACTERISTIC. van Deenen, P. J.; Matitti, T.; Vermeer, A. (FOM, Amsterdam). J. Sci. Instr., 42: 399-402(June 1965).

A battery-powered transistor amplifier is described with which the part of the probe characteristic in which the ion current predominates can be scanned using an oscilloscope. The amplifier is particularly useful when the ion saturation current is very small and the registration time is short (1 msec). (D.C.W.)

**32517** CHARACTERISTICS OF HYDROGEN THYRATRONS OF NANO-SECOND RANGE. Gel'tsel, M. Yu.; Panifilov, A. D.; Sobolev, S. S.; Yudin, L. I. (Inst. of Nuclear Physics, Academy of Sciences, Siberian SSR). Pribory i Tekhn. Eksperim., No. 2, 121-6(Mar.-Apr. 1965). (In Russian)

The results of the investigation of some parameters of commercial hydrogen thyratrons, investigated for clarification of the possibility of their use in generators for pulse of nanosecond length, were reported. Regimes occurred that made it possible to obtain stability of the delay of the discharge of ~±1 nsec during general delay of 50 to 200 nsec in dependence on the type of thyratron. The thyratrons investigated were TGII-50/5, TGII-325/16, TGII-400/16, TGII-700/25, and TGII-2500/35. (tr-auth)

**32518** ACOUSTIC PARAMAGNETIC SPECTROMETER. Golenishchev-Kutuzov, V. A.; Kharakhash'yan, E. G. (Kazan Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 126-30(Mar.-Apr. 1965). (In Russian)

The arrangement for the measurement of the absorption of sound in paramagnetics is described. It operates in continuous regime of the generation in the frequency range from 10 to 70 MHz in the temperature range from liquid hydrogen to room temperature. The principle of the operation was based on the measurement of the reaction of the generator in dependence on the acoustical resistance of the sample, placed in a static magnetic field. In the spectrometer, the change in the absorption coefficients could be measured at $\sim 10^{-3}$ to $10^{-6}$ $cm^{-1}$. (tr-auth)

**32519** STABILIZATION OF THE FIELD OF RE 1301 SPECTROMETER ELECTROMAGNET ACCORDING TO THE EPR OF EXAMINED SPECIMEN. Semenov, A. G.; Zhidomirova, E. M. (Inst. of Chemical Kinetics and Combustion, Academy of Sciences, Siberian SSR). Pribory i Tekhn. Eksperim., No. 2, 130-3(Mar.-Apr. 1965). (In Russian)

The attachment to the series electron paramagnetic resonance spectrometer RE 1301, permitting stabilization of the field of the electromagnet according to the EPR of the sample examined, is described. The installation makes it possible to maintain a stable relation of the frequency of oscillations $\nu_0$ of the klystron to the field intensity of the electromagnet $H_0$ during protracted time periods. The use of the attachment increases the stability ratio $\nu_0/H_0$ at ~1000 times for crystalline samples, containing $10^{14}$ noncoupled electrons. (tr-auth)

**32520** PORTABLE ELECTRON GUN WITH A TANTALUM CATHODE. Vishnyakov, V. A. Pribory i Tekhn. Eksperim., No. 2, 145-6(Mar.-Apr. 1965). (In Russian)

The construction of an electron gun with tantalum cathode, heated by the bombardment of electrons, was described. The characteristics of the given construction show the possibility of the substitution of cathodes without disturbance of the electrode arrangement. (tr-auth)

**32521** SPECTROGRAPH WITH MIRROR SCANNER. Bashilov, V. A. (State Scientific-Research Inst. of Power Engineering, USSR). Pribory i Tekhn. Eksperim., No. 2, 183-4(Mar.-Apr. 1965). (In Russian)

The device for the extraction of the scanning of the spectrum with time is described. The device has its own camera with a rotating mirror, connected to the output of the ISP-51 spectrograph. The speed for the scanning of the spectra can be changed within the limits of 375 to 3750 m/sec. (tr-auth)

**32522** UNIVERSAL PHOSPHOROSCOPE ATTACHMENT TO SF-4 SPECTROPHOTOMETER. Bobrovich, V. P.; Chernitskii, E. A.; Konev, S. V. (Lab. of Biophysics and Isotopes, Academy of Sciences, Belorussian SSR). Pribory i Tekhn. Eksperim., No. 2, 187-8(Mar.-Apr.1965). (In Russian)

The attachment described for the SF-4 spectrometer, in addition to fluorescent spectra and polarization spectra, makes it possible to measure the spectrum of reaction and spontaneous polarization both at room temperature and at low temperatures. It also makes it possible to obtain the analogous spectral characteristics of phosphorescence with resolution times of $10^{-3}$ sec. (tr-auth)

**32523** PARAMETRIC AMPLIFIERS OF ELECTRON TRANSVERSE WAVES. Lopukhin, V. M.; Roshal, A. S. Usp. Fiz. Nauk, 85: 297-334(Feb. 1965). (In Russian)

The parametric electron-beam amplifiers are very useful for operations at very high frequencies. By means of the parametric interaction of the electron beam, the fast waves may be amplified while improving stability and other properties, as compared with other types of amplifiers. The physical principles of parametric amplification of transverse electron-beam currents are reviewed, with special attention to the sources of noise means to suppress them, widening of the amplification band, the effect of longitudinal velocity and of the space charge and the influence of the relations between various wave types on the signal and the pumping frequency. The devices considered include systems with alternating and with electrostatic fields. The parametric electron-beam amplifiers exhibit the advantage of lower noise coefficient and broader bandwidth. They may be overloaded without danger and do not require a large auxiliary installation. The devices may be used advantageously as the input cascade and yield excellent results when used in radioastronomical systems. Their theory may be derived by means of the matrix method. 108 references. (TTT)

**32524** ON THE THEORY OF GAS LASERS. Popov, A. K. (Inst of Physics, Academy of Sciences, Siberian SSR). Zh. Eksperim. i Teor. Fiz., 48: 1279-2(May 1965). (In Russian)

The problem of gas-laser emission is solved by semiclassical theory methods. The dependence of the field density of the induced radiation on the resonator parameters, probabilities for atomic excitation per unit time in the gas discharge plasma, and on the relaxation characteristics of the system are found. The motion of the radiating particles, degeneracy of the levels, and chaotic orientation of the dipole moments of the transition are taken into account, as well as the presence of a mechanism for excitation of the lower level. (auth)

**32525** PULSE-HEIGHT-INSENSITIVE SPARK PULSE SHARPENERS. Mesyats, G. A. (Tomsk Polytechnic Inst., USSR). Zh. Tekhn. Fiz., 35: 516-18(Mar. 1965). (In Russian)

The operation of a spark pulse sharpener is briefly discussed theoretically from the point of view of minimum dependence of delay time on pulse height and accommodation of a maximum range of pulse heights without readjustment of the gap length. Methods for achieving the desired operating characteristics are: 1) choosing the working medium and electrode shapes so as to obtain a delay time nearly independent of pulse height and 2) forcing the desired relation between pulse height and delay time, possibly with the aid of an external circuit. The use of a gas as working medium is regarded as unpromising because of the strong dependence of electron avalanche development time on field strength; the vacuum gap is more suitable. The possibility is mentioned of employing a third electrode within the gap to which a voltage pulse of appropriate amplitude is applied sumultaneously with the arrival of the input pulse to be sharpened. The possibility is also mentioned of employing a large number of very short gaps in series. Recent experiments performed in collaboration with S. P. Bugrayev, employing vacuum surface breakdown of ceramics under conditions of highly nonuniform field in the cathode region, are mentioned. With pulses of $6 \times 10^{-10}$ sec rise time the range of working potentials was from 5 to 40 kv with a sharpening factor of 35. (ATD)

**32526** KEYED OSCILLATOR. Hazoni, Yohonathan (to Commissariat à l'Energie Atomique). British Patent 979,802. Jan. 6, 1965. Priority date June 13, 1960, France.

A keyed oscillator adapted for use in an amplitude discriminator is designed to increase the performances of amplitude analyzers by the reduction of the dead time. The oscillator includes a transistor, a tunnel diode disposed in the emitter circuit of the transistor, and means for injecting the control signal into the base circuit of the transistor. Means are provided for biasing the transistor so that in the absence of a signal the tunnel diode is located in a region of its characteristic curve that corresponds to a positive resistance, and in the presence of the signal the tunnel diode passes into a region of its curve that corresponds to a negative resistance to constitute an oscillator generator in the emitter circuit of the transistor. Means are provided for extracting the amplified oscillations from the circuit of the collector of the transistor. (B.L.M.)

**32527** IMPROVEMENTS IN OR RELATING TO MEASUREMENT OF THICKNESS. Aveyard, Sydney (to United Kingdom Atomic Energy Authority). British Patent 993,149. May 26, 1965. Filed Feb. 12, 1962.

A method and apparatus are described for measuring the thickness of material of an object between a first and sec-

ond surface of the article. The method employs ultrasonic vibrations and is particularly suited to the measurement of the thickness of tubes that have fins or other locally increased thicknesses. The apparatus includes a transducer as a source of pulses of ultrasonic vibrations, a variable frequency oscillator for energizing the transducer at an ultrasonic frequency, a collimator device of a disc of sound absorbent material with an axial hole for focusing the ultrasonic vibrations into a beam arranged to be directed at the first surface of an article. The articles and the transducer are immersed in a container filled with a liquid such as water. The reflected pulses received from the surface of the article includes a portion of a transmitted pulse and a portion of that same transmitted pulse reflected from the second surface of the article. Means are provided for varying the frequency of the oscillator and for determining the frequency at which destructive interference takes place and within which the reflected pulses exhibit a minimum. The received vibrations are displayed on a cathode ray oscillograph by which the destructive interference may be observed. The oscillograph has its base synchronized with the pulse repetition frequency of the oscillator. (B.L.M.)

**32528** IMPROVEMENTS IN THERMOCOUPLES. (to Philips Electronic and Associated Industries Ltd.). British Patent 994,235. June 2, 1965. Priority date Mar. 26, 1962, Netherlands.

A thermocouple is made up of one or more thermocouple wires embedded in an insulating material and enclosed in a metal sheath built up from two layers of different layers of metallic material soldered together. The sheath is brought to a smaller cross section than its original cross section over at least a part of its length by hammering, rolling, and/or drawing. The thermocouple is suitable for measuring high temperatures such as those present in nuclear reactors. (B.L.M.)

**32529** MAGNETRON TYPE MASS SPECTROMETER. Kreisman, Wallace S. (to Geophysics Corp. of America). U. S. Patent 3,162,760. Dec. 22, 1964. Filed Nov. 7, 1961.

The mass spectrometer includes housing, a filament adapted to produce a source of electrons, ion acceleration means located near the filament, and at least two concentric semicircular collectors located so as to partially surround the filament. Electric lead-out means are connected to each of the collectors. The sample is inserted in the region of the filament, and a magnetic field is produced axially to the collectors so that ions of a given mass will be acted on by the electrons and will be accelerated and will strike only the first collector. Circuitry connected to the lead-outs detect the ions striking the collector. Circuit means connected to the filament and collectors are provided for varying the various ions focused on the collectors. A double grid system, the second of which extends substantially to the first and second collector, establish a region having substantially no electrical field. This simplification of construction allows a lighter, smaller mass spectrometer having a high degree of sensitivity to be produced at a low cost. (B.L.M.)

**32530** CRYOTRON MEMORY. Bremer, John W.; Cotey, Oliver J. (to General Electric Co.). U. S. Patent 3,167,748. Jan. 26, 1965. Filed July 5, 1962.

A word-organized cryogenic memory unit with nondestructive readout requires only three currents for both writing and reading. A simple storage circuit includes three cryotrons associated with a superconductive loop for storing a persistent current. Writing, the establishment of the persistent current in the storage circuit, is accomplished by applying currents to a digit line and a write line. Reading, detection of a persistent current in the storage circuit, is accomplished by applying currents to the digit line and a read line. A plurality of storage circuits arranged in columns and rows make up the memory unit. The read and write lines are the row controls for selecting a word. The digit lines form the columns for parallel digit or bit selection. (B.L.M.)

**32531** NARROW BEAM ELECTRON SOURCE FOR THE ION SOURCE OF A MASS SPECTROMETER. Smith, Hayden M. (to Bendix Corp.). U. S. Patent 3,171,024. Feb. 23, 1965. Filed Sept. 13, 1961.

A channel electron multiplier is used to produce a narrow beam electron source for time-of-flight mass spectrometers. In this type multiplier the inside surface of the tube is conductive and has secondary emissive properties. The multiplier is positioned to receive electrons from an emitter, to multiply the electrons through secondary emission, and to produce at its output the required narrow beam. Since the electrons from the emitter are amplified, the emitter may be operated at a level below its saturation point, at which level a better range of control can be achieved. (A.G.W.)

**32532** PLASMA-BEAM SIGNAL GENERATOR. Targ, Russell; Ettenberg, Morris (to Sperry Rand Corp.). U. S. Patent 3,171,053. Feb. 23, 1965. Filed Dec. 15, 1959.

A plasma-beam signal generator is selectively operative over a broad band of signal frequencies and requires no external feedback circuits. A microwave signal interaction structure of the traveling-wave type is located adjacent one end of a hollow metallic cylinder. An electron gun at the other end of the cylinder directs an electron beam axially along the cylinder and through the interaction structure toward an insulated beam collector. The cylinder contains a controlled pressure of a suitable ionizable gas and is provided with an axial magnetic field. The electron beam modulated by the plasma formed in the cylinder enters the interaction structure and produces a traveling wave whose frequency is a function of the magnitude of the magnetic field. The amplitude of the traveling wave is related to the gas pressure. (A.G.W.)

**32533** NUCLEAR FLASH SIMULATOR. William D. Buckingham (to Western Union Telegraph Co.). U. S. Patent 3,171,057. Feb. 23, 1965. Filed July 19, 1960.

The thermal energy flash generated by a nuclear bomb explosion can be simulated by a combination of a photoflash lamp and a photospot lamp energized sequentially. The photoflash lamp is positioned in front of and on the optical axis of the photospot lamp. Means are provided to control the wave shape and the timing of the energizing signals fed to the lamps. (A.G.W.)

**32534** SPECTROSCOPIC APPARATUS. Baird, Walter S. (to Baird Atomic Inc.). U. S. Patent 3,171,882. Mar. 2, 1965. Filed Apr. 24, 1962.

A highly precise direct readout for a spectrometer is designed to compare an unknown sample, the composition of which is approximately known, with a standard, the composition of which is precisely known, by using the method of differences. (A.G.W.)

**32535** MASS SPECTROMETER. Behrisch, Rainer; Blauth, Erich W.; Melzner, Friedhelm; Meyer, Erwin H. (to Max-Planck-Gesellschaft zur Forderung der Wissenschaften e.V.). U. S. Patent 3,174,034. Mar. 16, 1965. Priority date July 3, 1961, Germany.

The performance of a dynamic-functioning mass spectrometer can be improved by continuously removing ions that are not in resonance and that constitute a space charge. This is accomplished by periodically varying the field that defines the ion trajectories and/or periodically superimposing an additional field in such a manner that ions not in resonance will be deflected from their trajectories and discharge themselves. The resulting field distortion should take place in such a part of the spectrometer at such a time that the resonating ions are not substantially influenced. (A.G.W.)

**32536** RADIOLOGICAL GAS ANALYZER. Vanderschmidt, George Frederick. U. S. Patent 3,174,035. Mar. 16, 1965. Filed Mar. 10, 1961.

The gas to be analyzed is passed through the space between a preferably cylindrical conductive housing whose inner surface serves as an anode and a coaxial inner cathode. A source of voltage is connected between the anode and cathode, and sources of radiation along the housing direct radiation into the space with an intensity such that its energy is absorbed in the gas. An indicator

connected between the voltage source and the electrodes indicates the ionization current passing between the electrodes. Foreign gas particles are indicated by a decrease in current thought to be due to the tendency of large gas molecules to recombine or to collect upon their surfaces ions otherwise generated in the gaseous medium. (A.G.W.)

**32537** THERMAL GAS ANALYZER. Hansen, Siegfried (to Hughes Aircraft Co.). U. S. Patent 3,174,327. Mar. 23, 1965. Filed Oct. 1, 1962.

The gas to be analyzed is admitted into a spherical condenser-evaporator and frozen uniformly upon the walls. The temperature of the condenser-evaporator is then increased to vaporize the frozen mixture. As each constituent is vaporized, its pressure is measured by an ion gage and that constituent is removed before another constituent is vaporized at a higher temperature. Each constituent is identified by its vapor pressure-temperature curve. (A.G.W.)

**32538** MAGNETIC FIELD FREE ION SOURCE WITH ADJUSTABLE ELECTRON GUN. Lilly, Arnys C., Jr.; Shutes, Emmett B.; Weismann, Theodore J. (to Guld Research and Development Co.). U. S. Patent 3,182,190. May 4, 1965. Filed July 31, 1962.

An ion source provides for the ionization of the material in the vapor state just prior to the exit of the ionized material from the ionization chamber. The ion chamber is provided with an exit opening from which the ions are extracted by means of an appropriately applied electric field. The extracted ions are accelerated and focused into a penicilliform ion beam. The ion chamber is provided with two other openings whose axis is transverse to the ion exit opening. At one of these openings a stream of accelerated electrons is projected into the chamber by the electron gun, and the electrons are collected by a trap at the diametrically opposite opening. The entire electron-gun structure is pivoted on an axis substantially perpendicular to the plane defined by the axes of the electron and ion beams. By means of the aiming of the electron gun control of the energy characteristics and intensity of the ion beam is attained. (B.L.M.)

**32539** ION GENERATOR COMPRISING A SHIELDED RADIOACTIVE SOURCE AND MEANS FOR FORCING AIR PAST THE RADIOACTIVE SOURCE. Fish, Walter Y.; Conlee, William H., Jr.; Martin, Thomas L., Jr. (to Wesix Electric Heater Co.). U. S. Patent 3,182,194. May 4, 1965. Filed Dec. 8, 1960.

An ion generator is described that effectively utilizes radiation from high energy radioactive sources to produce large quantities of ions of the desired sign at relatively low cost and at the same time is shielded in such a manner that it is not a radiation hazard. The ion generator consists of a member of low density material surrounding a member of high density material both having open ends. A radioactive source emitting rays having high energy level is mounted within the member of high density material. The spacing between the source and the member of high density material is such that it is less than the normal distance of travel of the radioactive rays in air so that the rays impinge upon the high density material to cause backscattering. A large number of positive and negative ions are created within the air space enclosed by the member of high density material. In order to separate the undesired from the desired ions, positive and negative charges are applied to the high and low density members to establish an electrostatic field between the members. Means are provided for introducing an air flow into the inner tubular member and between the two members. A radiation trap is mounted on the forward end of the inner tubular member. The trap is preferably a plastic plug provided with a number of holes drilled in a direction parallel to the longitudinal axis of the inner tubular member, and the holes permit the flow of air and at the same time acts as a radiation shield to prevent the escape of radiation. (B.L.M.)

**32540** MULTIPLY NEUTRALIZED ION SOURCE. Gabor, Dennis (to National Research Development Corp.). U. S. Patent 3,182,220. May 4, 1965. Priority date Mar. 18, 1959, Great Britain.

An ion beam source is described in which a large ion current of the order of hundreds or thousands of amperes is produced and accelerated to energies of 5 to 100 kev. The ion beam source includes two parts, the ion source proper in which the gas molecules are ionized and the accelerating region in which ions from the source are accelerated to a higher energy level and formed into a beam. A third region may be included in which the beam is converted into an ionic flywheel by a magnetic field in the form of a resultant of three component fields. In the source, a high frequency field is used to agitate the electrons and produce ionization by collisions with the gas molecules; and fields are set up to cause the ions generated to move towards the accelerating region while the electrons are caused to move toward the walls where they are drawn off by suitably placed electrodes. In the accelerating region, the ions are accelerated away from the source; and the space charge in the region is neutralized by means of electrons injected transversely into the beam at various points along it. Acceleration of electrons out of the beam is avoided by means of an arrangement of electric and magnetic fields. (B.L.M.)

**32541** CALIBRATOR FOR GAMMA RAY DENSITY MEASURING APPARATUS INCLUDING SETS OF ABSORBER PLATES INSERTABLE IN THE PATH OF RADIATION. Amrehn, Hermann (Chemische Werke Huls, AG). U. S. Patent 3,183,354. May 11, 1965. Priority date July 12, 1961, Germany.

A calibrator is provided for density measuring apparatus of the type that includes a gamma source, a liquid container, and a scintillation crystal disposed adjacent to the liquid container. The casing for the crystal is modified to contain the calibrator unit so that the casing has a sidewardly protrusion having a bore directed toward the crystal but out of radiation range of the gamma ray source. The protrusion on the casing defines a cylindrical cavity having its axis perpendicular to the extension of the bore, and a lead capsule is contained in the cavity. The capsule contains a centrally affixed calibrator gamma ray source. The capsule has two oppositely directed windows communicating with the calibration source and individually alignable with the bore. Means are provided for receiving and positioning calibration plates across the capsule windows to attenuate the gamma rays at predetermined but different angles. When the capsule is in a position in which none of the windows register with the bore, any radiation from the second source is blocked from the scintillation crystal. (B.L.M.)

## Radiation Detection

*Refer also to abstracts 31696, 31930, 32104, 32106, 32233, 32250, 32643, 32864, 33051, 33201, and 33644.*

**32542** (AAEC/TM-287) GEIGER FLOW COUNTERS FOR LOW-BACKGROUND APPLICATIONS. Urquhart, D. F.; Alexiev, D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1965. 21p. Dep.(mn).

Flat Geiger flow counters with low volume and large window area can be made in a variety of sizes and are easily shielded against cosmic radiation. The high efficiencies and low backgrounds which can be obtained with these counters make them suitable for the measurement of low level radioactive sources. The method of construction is described, and results are given of experiments designed to find the optimum operating conditions and to demonstrate the performance of these counters. (auth)

**32543** (AD-609255) SPACE PHYSICS INSTRUMENTATION. Final Report. (Space Technology Labs., Inc., Los Angeles, Calif.). Dec. 31, 1960. Contract AF04

(647)-619. 223p. (AFBMD-61-6; STL/TR-60-0000-19419). $6.00(CFSTI).

The properties of some new types of beta spectrometers and proton spectrometers for use in space were studied. A laboratory prototype and a light-weight prototype of a high-energy beta spectrometer were constructed. Tests were performed on these spectrometers as well as the high-energy beta spectrometer reported in STL/TR-59-0000-09950. Support work included construction and testing of a pulse-height analyzer, a linear pulse amplifier, a nano-second coincidence circuit, and gating circuitry for use in conjunction with the spectrometers. A laboratory luminescent chamber was constructed and tested at the California Institute of Technology's synchrotron. The energy of the primary radiation can usually be determined and a lower energy bound is always possible. Immediate applications include the investigation of the primary radiation near the earth with particular emphasis on gamma rays and neutrons, the detection of atomic or thermonuclear space explosions, the identification of hostile satellites, and certain fundamental high-energy physics experiments. (auth)

**32544** (AECL-2245) A PUSH-THROUGH CONTAMINATED CLOTHING MONITOR. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 12p. Dep.; $0.50(AECL).

A monitor is described which is designed to detect low levels of $\beta$ contamination on laundered clothes. It is provided with background compensation and can detect 4 nC of strontium-90/yttrium-90 spread uniformly on coveralls with background exposure rates up to 150 $\mu$R/hour. If the background is expected to rise to 5 mR/hour the sensitivity must be reduced to 30 nC of strontium-90/yttrium-90. Twelve garments can be monitored in a minute. (auth)

**32545** (CEA-R-2461) MESURES D'ISOTOPES RADIOACTIFS PAR SPECTROMETRIE $\gamma$ ET X A L'AIDE DE CRISTAUX INa. APPLICATION A LA RADIOCHIMIE DE CERTAINS PRODUITS DE FISSION ET D'ACTIVATION. (Measurement of Radioactive Isotopes by $\gamma$- and X-Ray Spectrometry with NaI Crystals. Application to Radiochemistry of Some Fission and Activation Products). Simonet, Pierre; Boile, Ginette; Simonet, Genevieve (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études NucléAires). Apr. 1965. 83p. Dep.(mn).

The measurement of a number of atoms N may be obtained by detection of one $\gamma$ ray emitted if its branching ratio $K_E$ is known (number of E energy $\gamma$ transitions/number of disintegrations): $N = (A/\lambda) = (N_{\gamma E}/K_E\lambda)$. This measurement is effected in well-defined geometry. $\gamma$ rays emitted by the source are detected by a calibrated NaI crystal which is connected to a photomultiplier delivering electric impulses analyzed by a multichannel analyzer. Crystals are chosen according to energy, intensity of measured rays and of background. Calibration is established with standard sources or by total absolute efficiency of a definite crystal. Half life and energy of measured photopeaks branching ratio were determined for these isotopes: $^{95}$Zr, $^{99}$Nb, $^{99}$Mo, $^{103}$Ru, $^{106}$Ru, $^{111}$Ag, $^{115}$Cd, $^{115m}$Cd, $^{125}$Te, $^{129m}$Te, $^{134}$Cs, $^{137}$Cs, $^{140}$Ba, $^{140}$La, $^{91}$Y, $^{141}$Ce, $^{144}$Ce, $^{147}$Nd, $^{156}$Eu, $^{110}$Ag, $^{124}$Sb, $^{239}$Np, $^{237}$U, and $^{241}$Am. (auth)

**32546** (CEA-R-2711) SOURCES ETALONS DE RADIOACTIVE — MESURES ABSOLUES AU MOYEN D'UN ENSEMBLE 4 $\pi$ $\beta-\gamma$. (Calibrated Radioactive Sources — Absolute Measurements Using a 4$\pi$ $\beta-\gamma$ Apparatus). Benoit, Paulette; Philis, Claude (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Mar. 1965. 128p. Dep.(mn).

The principle of the standardization of the radioisotopes by the 4$\pi$ $\beta-\gamma$ coincidence method is reviewed. Some theoretical examples are given emphasizing instrumental coincidences and their corrections. The experimental apparatus is described, and the choice of experimental conditions for many isotopes is discussed. Results are given and discussed. The preparation of the source is described. (auth)

**32547** (EUR-2274.e) PRELIMINARY RESULTS ON TIMING WITH PHOTOMULTIPLIERS AND SOLID-STATE DETECTORS. Bertolini, G.; Mandl, V.; Pedrini, A.; Stanchi, L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 56p. Dep.(mn).

Electronic instruments for a delayed coincidence spectrometer in the nanosecond region were developed, and a half life measurement of the 73.6-Kev excited level of $^{239}$Np was performed. Preliminary measurements of the time resolution with photomultipliers were done. (auth)

**32548** (HW-83480) 6144-CHANNEL TIME-OF-FLIGHT ANALYZER. Walker, R. A.; Russell, J. T. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 1964. Contract AT(45-1)-1350. 76p. Dep.; $3.00(cy), 2(mn) CFSTI.

Circuit diagrams, schematics, and operational characteristics of a 6144-channel time-of-flight analyzer are given. The analyzer can be used with 12 separate detectors, providing each detector with 512 channels. The use of the analyzer with 12 detectors distributed around a neutron-scattering target is outlined as an example. (T.F.H.)

**32549** (INSJ-85) STUDY ON THE CURRENT SHEET TYPE $\pi\sqrt{2}$ SPECTROMETER. Manabu Fujioka (Institute for Nuclear Study, Univ. of Tokyo (Japan)). Apr. 1965. 29p. Dep.(mn).

As a preliminary study for the construction of a high precision beta spectrometer, the possibility of realizing a focusing higher than the second order in a current sheet configuration was examined. The field distributions of a uniform current density solenoid in comparison with the $r^{-\frac{1}{2}}$ field were calculated for wide ranges of parameters. Optimum configurations were searched using an electronic computer. It was found that a third order axial focusing can be realized using two coaxial solenoids each having a gap, i.e., two pairs of coils with finite axial extension. Searching was also made for a fourth order focusing but was unsuccessful. Some properties of the obtained configurations are discussed. (auth)

**32550** (N64-18291) [PROGRESS REPORT ON PARTICLE DETECTION AND PARTICLE DETECTORS]. Ziock, K.; Ritter, R. C. (Virginia Univ., Charlottesville). Nov. 30, 1963. 4p. (NASA-CR-53389). $1.10(CFSTI).

An investigation is conducted of a method for increasing the active volume of lithium-drifted germanium semiconductor detectors. This method involves a combination of lithium-drifting and special geometrical configurations. (auth)

**32551** (NP-14962) THE NONDESTRUCTIVE TESTING OF FUEL ELEMENTS BY MEANS OF COMPTON RECOIL SPECTROMETRY. Annual Report. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). [1962]. IAEA Contract 180/RB. 32p. Dep.(mn)

Results of research are presented which show that it is possible to isolate the 661-kev $^{137}$Cs gamma line after fuel burning time of about 2 years and 2 weeks cooling time using Compton spectrometers with semiconductor detectors for Compton-electron determination. Design and performance of this system are described. (J.R.D.)

**32552** (TID-21945) THE EFFECT OF VARIOUS TREATMENTS ON THE THERMOLUMINESCENCE OF LITHIUM FLUORIDE EXPOSED TO LOW DOSES OF GAMMA RADIATION (thesis). Watson, Charles Ross (Washington Univ., Seattle). 1965. Contract AT(45-1)-540. 74p. Dep.(mn); 3.00(cy), 2(mn) CFSTI.

A study was made of a few of the many variables which affect the response of TLD-100 lithium fluoride, one of several phosphors in use in thermoluminescent dosimetry systems. Three of the treatment methods investigated render the lithium fluoride suitable for specific types of dose measurement. Treatment A, annealing with slow cooling, is the best method of lowering the background reading and restoring the lithium fluoride to give consistent

response. This treatment does lower the sensitivity but will find application in the measurement of doses larger than investigated where it is important to have the lowest possible background reading. This treatment is also applicable to the situation where repeated calibration is impractical. Treatment B, annealing with rapid cooling, lowers the background but without the consistency of response of treatment A. Thus, this treatment is valuable when available treatment time is minimal and it is possible to calibrate each batch of lithium fluoride. This treatment is satisfactory for occasional measurements of unknown doses where the lithium fluoride would be calibrated as a matter of course. Neither annealing treatment resulted in extraneous peaks. Treatment C, re-use after sieving, was unacceptable because of erratic response and large standard deviation of readings. Washing the lithium fluoride powder with ethyl alcohol reduced its usefulness by the introduction of extraneous peaks and large background thermoluminescence. Treatment D, which was no treatment at all, resulted in the most sensitive measurement of 580 mr. If it is known that the lithium fluoride will only be used to measure low doses (e.g. 580 mr), then it should be re-used without treatment. Larger doses require annealing to remove residual thermoluminescence. (auth)

**32553** (ZfK-PhA-16) EIN STABILER UND RAUSCHARMER LADUNGSEMPFINDLICHER VORVERSTARKER FUR HALBLEITERDETEKTOREN. (A Stable and Low-Noise Charge-Sensitive Preamplifier for Semiconductor Detectors). Kemnitz, Peter; Kaufmann, Claus (Deutsche Akademie der Wissenschaften zu Berlin (East Germany) and Zentralinstitut fur Kernphysik, Rossendorf bei Dresden (East Germany)). Sept. 1964. 14p. Dep.(mn).

A low-noise charge-sensitive preamplifier for semiconductor detectors is described. After a survey of the properties of the preamplifier that are required for spectrometry, some methods for the practical realization of these requirements are discussed. A variant of the Hahn circuit is especially suitable for this purpose. It produces a noise half-value width of 2.6 kev for silicon with forming time constants from 0.3 to 0.5 μsec. The effective input capacity is 8 nF. This corresponds to a change of the input pulse height of about 1% with a change of the input capacity from 20 to 100 pF. (tr-auth)

**32554** (UCRL-Trans-1193) PRODUCTION TECHNOLOGY OF SPARK CHAMBERS. Alikhanyan, A. I. Translated by M. Kassatkin (Univ. of California Lawrence Radiation Lab., Berkeley). 1965. 7p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

The construction of two types of spark chambers are described: those for evacuation and filling outside the pressure chamber, and those for which these operations are carried within the chamber. (D.L.C.)

**32555** NEW DOSIMETRY UTILIZING VOLUME EXPANSION. Okabe, Shigeru; Tsumori, Kunihiko (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 48-50(Mar. 1965).

For the measurement of absorbed dose of intense electron beams or x rays, many methods have been reported but all have some faults. A new method utilizing volume expansion due to absorbed radiation was developed. Measurable dose rate with this method is $10^2-10^9$ rad/min, and no consideration is necessary for the nonuniform absorption of electron beams in the matter. (auth)

**32556** $BF_3$ COUNTER GATING SYSTEM. Fukuda, Kyue; Okabe, Shigeru (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 63-5(Mar. 1965).

A new gate circuit for the $BF_3$ counter was developed to measure pulsed neutrons produced by an electron linear accelerator under intense x-ray bursts. The circuit can completely eliminate pile-up pulses of secondary electrons, about $10^4$ times as high as the neutron pulses, caused by the x rays in the $BF_3$ counter. (auth)

**32557** GAMMA-RAY DETECTOR USING INSULATING MATERIALS. [PART] II. Furuta, Junichiro; Hiraoka, Eiichi (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 85-7(Mar. 1965).

In this second report concerning the Compton dose meter, the energy dependence and direction sensitivity are discussed. The total dose and the dose of irradiated liquid sample for its application were measured directly. (auth)

**32558** ON THE REASONS OF WORK INSTABILITY OF G-M COUNTERS. EFFICIENCY CHANGES. MULTIPLE PULSES. Lesinski, J. Arch. Elektrotech., 14: 119-37 (1965). (In Polish)

The methods of measuring the instability of G-M counters are given. The reasons for the deviation of the real performance characteristic from the ideal characteristics are discussed. The influence of geometrical defects and electronegative particle on the efficiency changes as well as multiple pulses, as factors involving the work instability of G-M counters are analyzed. (auth)

**32559** SEMICONDUCTOR RADIATION DETECTORS. Deme, Sandor. Atomtech. Tajekoztato, 8: 244-5(1965). (In Hungarian)

Semiconductor-type detectors were first used for the detection of alpha particles, at a resolution of 0.6%. Recent advances in the preparation of high-purity Si made it possible to build spectrometers with a thicker barrier layer, suitable for studying high-energy protons and other charged particles. The barrier layer of the new Li-type detectors is more than 5 mm thick; these instruments may be used for the spectrometry of 2-Mev electrons with a resolution of 40 to 50 kev. The greatest achievement during the last 2 years in this field was the development of the high-resolution Ge gamma spectrometer. As a general rule, the resolution of semi-conductor detectors is about ten times better than that of scintillation spectrometers, but their efficiency is low. Therefore, they are especially suited for studies in low-energy nuclear physics. The chief drawback of these instruments is their price and their short useful life; they lose their excellent resolution after a few months in operation or 1 to 2 years of storage. On the other hand, their fabrication is simple enough to allow their preparation at the research institutes by the workers themselves. (TTT)

**32560** A CONTINUOUS DOSIMETRY BY USE OF THE FRICKE DOSIMETER. Sugimoto, Ken'ichi; Tsujino, Ryuzo; Musha, Soichiro. Bull. Univ. Osaka Prefect., Ser. A, 11: 75-80(1963).

Potentiometry was applied to rapid and continuous measurements of radiation dose using the Fricke dosimeter. An irradiation vessel equipped with a platinum indicator electrode and a reference electrode (saturated calomel electrode) was used and the potentials of the irradiated ferrous iron solution were measured against the saturated calomel electrode (S.C.E.) during irradiation. The potential measurements were made at various ferrous iron concentrations and various dose rates. The potential started from about 380 mv vs. S.C.E. and increased gradually with increasing radiation dose until it reached about 465 mv. The gradient of the potential curve changed with the change of the ferrous iron concentration, but did not change with the change of dose rate. It was found that the potential values observed are in good agreement with the ones calculated from the Nernst equation for ferrous-ferric iron couple in the range of the oxidation ratio from 0.3 to 0.7. As a consequence, the potential vs. dose curve can be used for the simple and continuous dosimetry. The errors are within 2% at suitable conditions. Good reproducibility over the wide range for the potential measurements was found. (auth)

**32561** A LARGE-VOLUME, COAXIAL, LITHIUM-DRIFT, GERMANIUM GAMMA-RAY SPECTROMETER. Malm, H. L.; Tavendale, A. J.; Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 43: 1173-81(July 1965). (AECL-2301)

A high-resolution, germanium p-i-n diode gamma-ray spectrometer was made using the coaxial method of lithium drift. The detector described is ~16 $cm^3$ in sensitive volume, three to four times that of the largest "planar" drifted

diodes of this type described to date. Its performance as a spectrometer is comparable with that of smaller diodes; resolutions (fwhm) of 3.3 and 4.8 kev were obtained at γ-ray energies of 122 and 1,333 kev respectively with a detector bias of 1,000 to 1,500 v. Typical γ-ray spectra obtained with sources of $^{57}Co$, $^{60}Co$, $^{137}Cs$, and Th(B + C + C'') are shown. Also shown are curves of intrinsic full-energy peak efficiency over a range of energies. This efficiency is 2.5% at 1,300-kev γ-ray energy—comparable to that of a NaI scintillation spectrometer 1 in. in diameter by 1 in. long. (auth)

**32562** NEW CRITICAL STUDY OF THE RESULTS OF RADIOACTIVITY MEASUREMENTS (WITH A SCINTILLATOR COUNTER). Assche, M. van. Compt. Rend. Acad. Agr. France, 49: 503-8(1963). (In French)

The radioactivity of $^{14}C$ was measured with a scintillator counter, and the results were critically examined to determine the factors affecting the initiation of a pulse by a preceding pulse. The results showed that the distribution of countings and of self-movements follows the same mathematical model and is due only to chance. (J.S.R.)

**32563** NEW PARTICLE DETECTORS. PART III. Somogyi, Gyoergy (Lajos Kossuth Univ., Debrecen, Hungary). Fiz. Szemle, 15: 392-6(Dec. 1964). (In Hungarian)

The interaction of high-mass particles and certain special detector materials results in the formation of channel-like voids which may be rendered visible by treatment with suitable chemicals. The method may be used to visualize the track of particles. The method is based on the radioinduced destruction of the crystal lattice; the whole process is similar to the development of dislocations by etching. Aqua regia and HF have been successfully used for showing the path of radiation. Sensitivity tests have been carried out on some materials, including muscovite mica and cellulose nitrate. Void detectors have been successfully applied to neutron dosimetry to determine the thermal neutron flux after exposing the detector covered with a U oxide layer. The tracks remain stable at relatively high temperatures and for very long time period, making the method suitable for geochronological applications. The previously reported "fossile tracks" are assumed to have been caused by the fission of U impurities in micas. The detector may be applied from very low fluxes up to about $10^{23}$ n/cm$^2$. (TTT)

**32564** USE OF ELECTRON-SENSITIVE NUCLEAR EMULSIONS FOR ELECTRON DETECTION IN β SPECTROSCOPY. Juhasz, Sandor (Inst. of Experimental Physics and Inst. of Nuclear Studies, Debrecen, Hungary). Fiz. Szemle, 15: 85-7(Mar. 1965). (In Hungarian)

Beta spectroscopy is an important tool for studying the spectrum of conversion electrons because it makes it possible to examine low-intensity lines and short half-life isotopes without the necessity of introducing corrections for decay. Unfortunately, the usually employed photographic method is not sufficiently sensitive toward electrons and requires the use of high specific-activity beta sources coupled with long exposure times. Nuclear emulsions were found to be much more sensitive and may be used for the analysis of conversion-electron spectra. In view of strong scattering at electron energies beyond 250 kev, the emulsion should be at least 50 μ thick. In the 40- to 250-kev range, nuclear emulsions are not suitable, but at lower energies they may be used again with an efficiency of 100% down to 12 kev and 95% to 10 kev. (TTT)

**32565** IMPROVED FLOW TYPE COUNTER. Imai, M.; Yamata, S. Genshiryoku Kogyo, 9: No. 7, 41-5(1963). (In Japanese)

In order to improve flow-type counters, the internal construction of counters was studied, together with the effects of amplifier characteristics. Counter characteristics were investigated under different conditions using two types of amplifiers. Counting losses and discharge characteristics were also studied, particularly the transition from the proportional counter regime to the Geiger-Mueller counter regime. (D.C.W.)

**32566** SEMICONDUCTOR RADIATION DETECTORS. Terada, D. Genshiryoku Kogyo, 9: No. 8, 49-56(1963). (In Japanese)

Advantages of semiconductor detectors are given, with emphasis on p-n silicon detectors of 2.5, and 12.5 mm dia. The results of studies on alpha particles to 13 Mev showed the energy output is linearly dependent on the alpha energy. Spectrum resolution is high: the alpha spectrum from $^{210}Po$, measured with a 12.5-mm-dia detector, showed a half-width of 24 kw. For wider application of such detectors the lithium-drift method is used, the high diffusion coefficient permitting a high drift transfer coefficient. Such a detector with a semiconductor is equivalent to a gas-filled ionization chamber. Its external appearance and construction are identical with a p-n detector. Its window diameter is 5 mm, useful area 20 mm$^2$, characteristic zone thickness 1500 m. (IIC-M.G.)

**32567** ABSOLUTE THERMAL NEUTRON FLUX MEASUREMENTS USING NON-PERTURBING FOILS. Walker, J. V.; Randall, J. D.; Feltz, D. E. (Texas Agricultural and Mechanical Univ., College Station). Intern. J. Appl. Radiation Isotopes, 16: 377-83(June 1965).

Foils prepared with a moderating ratio equal to that of the medium in which they are to be used will induce no significant perturbation in the thermal neutron flux. Furthermore, when used in liquid form they are immediately adaptable to conventional absolute counting techniques. Thus, simple measurements can yield accurate and absolute values of thermal neutron fluxes. The liquid foils are not restricted to any shape and offer unparalleled flexibility. For example, extended geometries can be used to obtain fluxes averaged over the volume of the detector. It is our considered opinion that the liquid foil technique should be considered for any measurement of absolute thermal fluxes. (auth)

**32568** COMPARISON OF VARIOUS METHODS FOR MEASURING BETA AND GAMMA ACTIVITIES. Barychevs, L. Ya.; Bochkarev, V. V.; Garapov, E. F.; Gryaznov, Yu. N.; Denisikov, A. I.; Dorofeev, G. A.; L'vova, M. A. Izmeritel. Tekhn., No. 1, 48-50(Jan. 1965). (In Russian)

Standard solutions of $Co(NO_3)_2$ containing $13.7 \times 10^{13}$ disintegrations/sec m$^3$ of $^{60}Co$ activity and of $Fe_2(NO_3)_3$ containing $4.4 \times 10^{13}$ disintegrations/sec m$^3$ of $^{59}Fe$ activity were prepared and distributed for counting in a number of USSR laboratories. The samples were compared by beta-gamma coincidence counting on a stilbene detector and a NaI(Tl) crystal, by gamma-gamma coincidence counting on 40 × 40 mm NaI(Tl) crystals, by 4π beta proportional counting on thin collodion or gold-plated vinylchloride films, by counting on an end-window counter, and by counting in an ionization chamber. The corrections for dead time, absorption, accidental coincidences, etc., did not exceed 1 to 2%. The results show that beta-gamma and gamma-gamma coincidence counting, and 4π beta counting give values within ±1% of the absolute values. Comparative counts of other activities are being carried out. (TTT)

**32569** BUBBLE CHAMBER PICTURE ANALYSIS SYSTEM. Ijaz, Razia B. (Ohio Univ., Athens). J. Nat. Sci. and Math., 4: 1-7(Oct. 1964).

A simple semi-automatic scanning and measuring system for bubble chamber pictures is described. The measuring accuracy of the digitized measuring projector is ±2 micron and the speed of measurements is about 10 events per hour for two and four prong events. (auth)

**32570** A SIMPLIFIED TECHNIQUE FOR THE CALIBRATION OF DETECTORS USED IN THE MEASUREMENT OF NEUTRON SOURCE OUTPUTS. Thompson, I. M. G.; Clarke, R. W.; Lavender, A. (Central Electricity Generating Board, Berkeley, Glos, Eng.). J. Nucl. Energy, Pt. A & B, 19: 363-4(May 1965).

A method is described for the calibration of detectors to be used in the measurement of neutron source outputs by the manganese bath method. A measurement of the output of an americium-beryllium source is summarized. (D.C.W.)

**32571** CURRENT-SENSITIVE NUCLEAR INSTRUMENT. Miwa, Hirohide; Kasai, Tatsuo; Hayashi, Hajime (Kobe Kogyo Corp., Kobe-shi, Japan). J. Nucl. Sci. Technol. (Tokyo), 2: 183-90(May 1965).

The radiation detector is by nature a current generator of high output impedance. A current sensitive amplifier of low input and high output impedance can be devised for incorporation in a nuclear electronic system, providing a matched impedance at the terminal of the detector cable. The amplifier output is given by $i \times Ai$ (i: detector current output pulse, Ai: current amp gain), when the amplifier rise time ($t_r$) is faster than the current pulse rise time. Meanwhile, when $t_r$ is longer than the current pulse width, the output should be defined by $Q/t_r \times Ai$ (Q: detector output charge) in amp/coulomb units. The rise time of fission counters, $BF_3$ counters, PR gas-flow proportional counters, and inorganic scintillators with conventional photomultipliers is short and is even shorter in the case of fast photomultipliers combined with organic scintillators and semiconductor detectors. Thus marked improvement in signal-to-noise ratio can be expected from a current-sensitive system, and this was proved even with a slow amplifier ($t_r \doteq 200$ ns), not to mention what can be expected with a faster amplifier ($t_r < 20$ ns). G-M tubes are, inherently, slow, and combination with slow amplifiers does not distort the current pulse shape. Current pulse transmission via cable is more rational and easier than the conventional voltage pulse transmission. G-M tube current pulses were successfully sent over a distance of 1 km without any preamplifier or pulse transformer. (auth)

**32572** THE PROGRESS OF AUTOMATION OF PHOTOGRAPHIC DOSIMETRY, APRIL 1964. Heard, M. J. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phot. Sci., 12: 312-18(Nov.-Dec. 1964). (AERE-M-1371)

The increasing scale and complexity of routine personnel monitoring work has introduced the need for automation. Current progress in automation in the measurement of monitoring film density and of the counting of recoil protons in nuclear emulsions used for fast neutron monitoring is reviewed. Other aspects of automation in this field are covered briefly. (auth)

**32573** THE DOSIMETRY OF MIXED RADIATIONS, INVOLVING MORE THAN ONE ENERGY OR TYPE OF RADIATION, WITH THE R.P.S./A.E.R.E. FILM DOSIMETER. Jones, B. E.; Marshall, T. O. (Radiological Protection Service). J. Phot. Sci., 12: 319-27(Nov.-Dec. 1964).

The design of the R.P.S./A.E.R.E. film holder is basically suitable for the evaluation of single quality radiation doses. In practice, however, doses may be recorded which consist of mixtures of X, $\beta$, and $\gamma$ radiations with a variety of different energies, and to deal with these suitable methods have been devised empirically. The assessment of mixed doses of the same type of radiation but with different energies is shown to be reasonably straightforward. However, doses involving mixtures of $\beta$ and $\gamma$ radiations are more difficult to determine. Reasonable accuracy is attained provided the $\gamma$ energy is above about 22 kev, but below this value no suitable method exists with the present design of holder. However, a method employing the use of high Z metallic filters is discussed and shown to be satisfactory if the practical difficulties can be overcome. (auth)

**32574** THE DEPENDENCE OF THE CURRENT OF AN IONIZATION CHAMBER ON THE MODULATION FREQUENCY OF THE INTENSITY OF RADIATION. Oppelt, Jiri (Inst. for Research, Production, and Application of Radioisotopes, Prague). Jaderna Energie, 11: 59-62(Feb. 1965). (In Czech)

A mathematical treatment is given of the dependence of the current in an ionization chamber on the frequency of modulation of a radiation source. According to the equations derived, when the period of the modulation is long compared to the collection time of the ions, the amplitude of the ionization current has the same course as that of the radiation intensity with its amplitude of oscillation equal to half the current without modulation. The equation predicts that at periods short compared to the collection time (high frequency modulation) the alternating current component is zero. The equation also predicts that when the ratio of collection time to period of modulation is a whole number (1, 2, 3, ---) the alternating component is zero, with maxima at values between. This points up the necessity of using a stable modulation frequency in order to have a stable value of ionization current, when such a method of measurement is used. (TTT)

**32575** EXPERIMENTAL STUDIES OF THE RELATION BETWEEN THE CURRENT OF IONIZATION CHAMBER AND THE RADIATION INTENSITY FREQUENCY. Hospes, Miroslav (Ustav pro Vyzkum, Vyrobu a Vyuziti Radioizotopu, Prague). Jaderna Energie, 11: 62-3(Feb. 1965). (In Czech)

The experimental verification of the amplitude dependence of the ionization current on the modulation frequency, which was predicted is described. This dependence can be a source of error with measuring equipment with which modulation of the radiation is used. At least qualitative agreement of the experimental results with the theoretical calculations is shown. The calculation of the correction was not carried out because the required parameters were unknown. Curves are given showing the change of ionization current with chambers filled with nitrogen and with air. With nitrogen the current decreases up to a frequency of about 400 cycles per minute and then is nearly constant. With air-filling the curve shows definite maxima and minima. (TTT)

**32576** PREPARATION OF RADIOACTIVE SPECIMENS FOR AUTOMATIC MEASUREMENTS. Kubalek, Jiri. Jaderna Energie, 11: 63-6(Feb. 1965). (In Czech)

A brief description is given of two types of changing mechanisms for automatic measurement of radioactive samples, both of which are manufactured by the Tesla VZ Industries. These are designated types NCZ615A and NCZ616A. Considerable detail on the mechanical and electrical construction of both units is included. NCZ615A will handle 32 planchets 30 × 8 mm, while NCZ616A will handle up to 500. Both types permit the use of several alternative radiation detectors. (TTT)

**32577** A FAST NEUTRON STANDARD DOSIMETER OF THE HURST TYPE SIGNED BY A SIMPLE ELECTRONIC PULSE ANALYSIS. Abel, H.; Regel, K.; Eichhorn, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 8: 236-42(Apr. 1965). (In German)

The design and the calibration of a fast neutron Hurst-type dosimeter are described. The dosimeter has a simple electronic pulse analysis. (auth)

**32578** BUBBLE CHAMBERS OF THE FUTURE. Henderson, Cyril (University Coll., London). New Scientist, 26: 306-9(Apr. 29, 1965).

A brief review is given of the development of bubble chambers, and a description is given of existing chambers and their operation in the study of high-energy interactions. The design of new chambers having all the properties for the accurate measurement of charged particles already possessed by the two-meter class of hydrogen chambers, which can also detect and make measurable the momentum and direction of a neutral pi-meson, is discussed. Diagrams are presented of the proposed Brookhaven hydrogen chamber. (L.B.S.)

**32579** RADIOACTIVE MATERIALS IN PHARMACY. III. THE MEASUREMENT OF RADIATION. Spaander, P. (Rijks Instituut voor de Volksgezondheid, Utrecht). Pharm. Weekblad, 98: 1043-52(Nov. 8, 1963). (In Dutch)

The general introduction includes the effect of radiation on photographic emulsions and the use of scintillation counters. Measurements depending on ionizing effects are reviewed next; these methods include the use of ionization chambers, proportional counters, and Geiger-Müller counters. The best methods for the measurement of $\alpha$ particles (flow counters, scintillation effect), $\beta$ particles (Geiger-

Müller counters, liquid scintillation counters), and γ rays (Geiger-Müller counters, scintillation counters) are reviewed. Further remarks on the measurement of radiation with a Geiger-Müller counter relate to correction factors and experimental arrangement: geometrical factors, back scattering, absorption by air and the window, self absorption, dead time, zeroing, and the statistical properties of radioactivity. The biological effects of ionizing radiation are introduced, with note taken of the free radical theory and the target theory. Finally, the applicability of results of radiation experiments for man are discussed. (BBB)

**32580** ELECTRONIC DEVICE FOR TWO-DIMENSIONAL TIME-OF-FLIGHT SPECTROMETER FOR FAST PARTICLES. Kurashov, A. A.; Pankratov, V. M.; Perov, P. E. (Inst. of Nuclear Energy, State Atomic Energy Commission, USSR). Pribory i Tekhn. Eksperim., No. 2, 42-8(Mar.-Apr. 1965). (In Russian)

The electronic device for two-dimension time-of-flight spectrometer was described. The spectrometer was designed for investigation of the energy and mass distribution of fission fragments. The resolving time of the spectrometer is ~3 nsec. The channel width is 0,65 to 1,2 nsec. The number of channels is 256 × 256 and 512 × 512. The data recording is immediately done on paper tapes with a perforator. The speed of recording is 5 correlative events per second. The data received is processed in electronic computers. (tr-auth)

**32581** PHOTOEFFICIENCY OF A SCINTILLATION GAMMA-SPECTROMETER. Vartanov, N. A.; Samoilov, P. S.; Aver'yanov, E. G. Pribory i Tekhn. Eksperim., No. 2, 48-51(Mar.-Apr. 1965). (In Russian)

A method for the calibration of γ spectrometers with NaI(Tl) crystals by relative photoefficiencies is described. The γ transition cascades accompanying the radioactive decay of $^{22}Na$, $^{24}Na$, $^{46}Sc$, $^{60}Co$, and $^{93m}Mo$ were used for the calibration. The areas near the peaks of full absorption in the γ spectrum were determined; the difference of the areas gave the distinction between the photoabsorbed γ quanta of corresponding energy. The results, obtained for five cascades, gave curves of comparative photoefficiencies in the energy range from 0,265 to 2,760 Mev. The comparison of the results with Monte Carlo calculations showed satisfactory agreement of experiment and theory. (tr-auth)

**32582** DETERMINATION OF THE RESOLVING POWER OF SCINTILLATION GAMMA-SPECTROMETER BY MEANS OF RADIOACTIVE $Co^{60}$ SOURCE. Aver'yanov, E. G.; Vartanov, N. A.; Samoilov, P. S. Pribory i Tekhn. Eksperim., No. 2, 52-3(Mar.-Apr. 1965). (In Russian)

The dependence of the ratio of the maximum of stable lines to the minimum between lines for radioactive $^{60}Co$ was determined from the inverse intensity of the square of the energy resolution of a scintillation spectrometer with NaI(Tl) crystals for γ lines of 1,33 Mev. In the results of the calculation experimental corrections were introduced to the drop of the Compton continuum in the ranges of the minimum between lines. The dependence obtained gives the possibility of fast and reliable determination of the energy resolution of scintillation γ spectrometers for γ lines at 1,33 Mev; after suitable conversion it is possible to proceed to the evaluation of the resolution of the γ lines of any other energy. (tr-auth)

**32583** THE INFLUENCE OF FINITE GEOMETRY ON THE ENERGY DISTRIBUTION OF PARTICLES RECORDED IN A TELESCOPE WITH A SMALL RADIATOR. Voitovetskii, V. K.; Korsunskii, I. L.; Pazhin, Yu. F. Pribory i Tekhn. Eksperim., No. 2, 54-9(Mar.-Apr. 1965). (In Russian)

For telescopes with a small radiator the angular and energy distribution functions of the registered particles were obtained (by recoil scattering of neutrons on hydrogen and by inelastic scattering on deuterium). (tr-auth)

**32584** ANALYSIS OF THE EXPANSION OF LIQUID HYDROGEN IN A BUBBLE CHAMBER. Belonogov, A. V. Pribory i Tekhn. Eksperim., No. 2, 60-2(Mar.-Apr. 1965). (In Russian)

A method for the analysis and calculation of the process of expansion of liquid hydrogen in a bubble chamber is reported. The Van der Waals equation with new coefficients is used for the calculation. The theoretical and experimental curves of the expansion process for liquid hydrogen in the bubble chamber are given. (tr-auth)

**32585** SLOW NEUTRON DETECTOR WITH HIGH LUMINESCENCE YIELD. Vedekhin, A. F.; Kuchernyuk, V. D. (Scientific-Research Inst. of Geophysics, USSR). Pribory i Tekhn. Eksperim., No. 2, 65-9(Mar.-Apr. 1965). (In Russian)

The construction of a cylindrical detector for slow neutrons with high luminescence yield is described. It differs from existing detectors in that the slow-neutron sensitive compound, placed in radial channels, is a luminescent solution. In dependence on the number of channels, their width, and their depth, as well as on the type of luminescent compound, the scintillation meter with the photomultiplier FEU-35 has in counting characteristics a plateau extending from 150 to 300 v with a slope of 3 to 75% per 100 v. The detectors can be used with the heat-stable photomultiplier FEU-66 for the recording of neutrons at the temperature T = 100°C. (tr-auth)

**32586** DESIGN OF A PHOTOMULTIPLIER WITH NANO-SECOND COINCIDENCE RANGE. Vysochanskii, M.; Mukhin, S. V.; Rikhvitskii, S. V.; Semenyushkin, I. N.; Foltin, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 88-91(Mar.-Apr. 1965). (In Russian)

The results of the tests on FEU-36, operated by high-frequency voltage, in a two-channel coincidence arrangement were reported. In frequency-controlled operation $I$ = 70 Mev resolving times $\tau \cong 1$ nsec were obtained. (tr-auth)

**32587** DOSE RELATIONS ON PERSPEX-METAL INTERFACE WITH 20 MV X-RADIATION. Wambersie, A.; Dutreix, J.; Bernard, M. (Institut Gustave Roussy, Villejuif, France). Radiobiol. Radiotherap., 6: 237-44 (1965). (In German)

In former measurements performed with a flat ionization chamber a large change of ionization on the interface of two different media could be detected. In order to support these results two other types of radiation detectors were used. Results are reported for ferrosulfate and bacteria (E. coli). For technical reasons the relations could only be obtained with 20 Mv x radiation. For this type of radiation the values found with the ionization chamber were confirmed. (tr-auth)

**32588** CONTRIBUTIONS TO DOSIMETRY OF MOULAGES. Pentchev, P. P. (Krebsforschungsinstitut, Sofia). Radiobiol. Radiotherap., 6: 245-9(1965). (In German)

A comparison of calculated and measured dose values with moulages shows differences to occur up to ± 43%. By means of systematic investigations connections are analyzed and it is concluded that with the most practically used moulages a direct measurement of dose should be done. (tr-auth)

**32589** ABOUT THE USE OF SPECIAL UNITS IN THE MEASUREMENT OF IONIZING RADIATION. Rothe, H. (Deutsches Amt fur Messwesen und Warenprufung, Berlin). Radiobiol. Radiotherap., 6: 295-301(1965). (In German)

A recommendation is given concerning the use of the special units Röntgen, rad, and Curie, as well as of the radiation quantities belonging to them. By means of this recommendation a uniform use in this field should be guaranteed until a definitive regulation is presented in the table of legal units. The necessity of such a recommendation is briefly demonstrated. (tr-auth)

**32590** A COMPTON COMPENSATED GAMMA SPECTROMETER. De Soete, D.; Hoste, J. (Universiteit, Ghent). Radiochim. Acta, 4: 35-8(May 1965).

Gamma spectra with sharp photopeaks can be obtained by the method proposed by Pierson et al. According to this technique the output of an anthracene scintillator was

subtracted from the output of a NaI(Tl) detector as the former gives Compton effect only. The technique was modified to give the following improvements: use of a large plastic detector, resulting in a better detection efficiency at lower cost; detectors positioned at a 90° angle to reduce backscatter by a factor of five; and use of a lead grating to achieve accurate compensation over a wide energy range. Both anthracene and plastic scintillator by themselves gave imperfect compensation, as it is not possible to take into account multiple Compton interaction in the NaI(Tl) detector, leading to total absorption. A lead grating of adequate design, placed before the plastic detector, induced a sufficient amount of absorption to allow an accurate compensation over the energy range from 0.2 to 2.7 Mev. Use of a multichannel analyzer allowed the measurement to be done in one single operation and made a background correction possible. The mean square deviation on the baseline in the Compton region was ±2.7% relative to the peak of a $^{60}Co$ source. (auth)

**32591** ZURCHER PROPOSAL FOR RADIOMETRY AND DOSIMETRY. Schinz, Hans R.; Wideroee, Rolf. Strahlentherapie, 127: 1-13(May 1965). (In German)

Radiometry and dosimetry must be kept distinctively separate. Dose measurements are applicable to the body only. The radiation field is characterized by the radiation density. Measurements of ionizing radiation expressed in terms of Roentgen or Rho, belong on principle neither to radiometry nor to dosimetry, but may be used for the determination of radiometrical or dosimetrical values. The unit for the dose is rad (not Roentgen!). The Planck is proposed as a new unit for the radiation density. The names for the values and units allow an immediate recognition of the phenomena involved. (tr-auth)

**32592** THE EFFECT OF A SLIT SYSTEM ON OBSERVED RADIATION COUNTING RATES. Archbold, Thomas F. Trend Eng. Univ. Wash., 17: No. 2, 14-19(Apr. 1965).

Any radiation measuring instrument employing a slit gives a distorted picture of the actual distribution of radiation intensity in the source. An analysis of a scanning system designed to determine accurately the distribution of $^{65}Zn$ near grain boundaries in zinc is outlined. Although the experiments with zinc are unsuccessful because of low levels of radioactivity in the grain boundaries, it is demonstrated that recorded counting rates are the result of convolutions of functions representing symmetric sources of radiation with a function representing the instrument. (auth)

**32593** INSTRUMENTATION IN CARBON-14 RESPIRATION PATTERN STUDIES. Tolbert, B. M.; Cozzetto, F. J. (Univ. of Colorado, Boulder). p.405-17 of "EUR-2200.e."

Instrumentation is described that was designed for the measurement of respired $^{14}CO_2$. Biological parameters that influenced design are reviewed. Instrument components and measuring methods are described. The computer processing of respiration pattern data is discussed. (C.H.)

**32594** GAMMA ASSAY WITH LITHIUM DRIFTED GERMANIUM SEMICONDUCTOR NUCLEAR DETECTORS. Friedland, S. S. (Solid State Radiations Inc., Los Angeles). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/55, 12p. (CONF-650507-33). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The characteristics and applications of the semiconductor nuclear radiation detector which has been fabricated from germanium and compensated to high resistivity by the Pell lithium drift method to obtain a large sensitive volume for gamma ray detection are presented. Detector thicknesses of 1 to 4 mm are readily fabricated whereas 6 mm and greater are low yield devices. Areas of 1 to 6 $cm^2$ are available only yield depends inversely upon the area. Gamma resolutions of less than 10 kev are obtainable under standard laboratory conditions and less than 3 kev under ideal conditions. Such high resolutions will have immediate effect on gamma assay as it may prove possible in many applications to remove the need for chemical separation. Results with $^{207}Bi$, $^{166}Ho$, and other sources will be shown. (auth)

**32595** OPTICAL DENSITY CONTROL OF AUTORADIOGRAPHS AFTER PHOTOGRAPHIC PROCESSING. Baptista, A. M.; Terrinha, A. (Instituto Portugues de Oncologia, Lisboa, Portugal). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/77, 7p. (CONF-650507-8). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Results of an attempt to control the grain density after development and fixation of the photographic material by attacking the processed emulsion with dilute solutions of trypsin are reported. By changing concentrations and temperature the attack can be made to proceed at any desirable speed and so the trypsin solution acts as an ultra microtome removing very thin layers of the photographic emulsion. More important the process could be followed continuously under the microscope by using a suitable chamber. Results are presented which suggest that this technique gives a rough idea of the incorporation with time of the radionuclide in the biological structure under observation. (P.C.H.)

**32596** VARIATION OF SAMPLE PROPERTIES AS A SOURCE OF ERROR IN GAMMA SPECTROMETRY OF LARGE VOLUME SAMPLES. Castren, O. Sateilyfysiikan Laitos, Helsinki). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/11, 21p. (CONF-650507-27). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Errors in gamma spectrometry may be divided into two main groups: errors in the counting efficiency, and errors in the net count rate determined on the basis of the gamma spectrum. Variation of sample properties may cause both types of error. The treatment of the problem is restricted to the case where net count rate is the count rate in the full energy peak. Because the amount of scattered photons contributing to the full energy peak must be small, only sample inhomogeneity and changes of absorption properties must be taken into account in the discussion of the first group errors. It is further assumed that the effective background can be estimated on the basis of the gamma spectrum, so that errors of the second group may be neglected. The problem was treated by calculating the detection efficiency of a cylindrical crystal for a point source in various positions around the crystal. For this purpose an analytical expression derived by Vegors et al. was used for points situated in a coaxial cylinder having the same diameter as the crystal. For points outside this cylinder new expressions were derived. (P.C.H.)

**32597** RECENT METHODS FOR THE AUTOMATIC EVALUATION OF THIN-LAYER AND PAPER RADIOCHROMATOGRAMS. Berthold, F. (Berthold-Laboratorium, Wildbad, Ger.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/31, 14p. (CONF-650507-4). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

The development and results obtained with a new instrument for the automatic scanning of thin-layer and paper chromatograms labeled with radioisotopes are reported. Using a novel kind of gas flow detector, it is possible to measure all beta-emitters, including tritium, without contact with the probe. Essentially the apparatus consists of a detector and a transport mechanism passing the radiochromatogram below the detector diaphragm. In view of the small half-value layer of tritium-beta-particles in air (approx. 0.3 mm) a strong dependence on distance between detector and chromatogram would be expected. However, there is practically no dependence between 0.5 and 2 mm distance. The explanation presented is that due to the special counter parameters the electrical field extends through the opening of the diaphragm into the space between counter and chromatogram, thereby pulling negative charge car-

riers produced by ionizing radiation even outside the counter volume into the region of gas amplification around the anode wire. Therefore, the instrument allows fast, direct, and non-destructive measurement of thin-layer plates even for the case of tritium, as opposed to the common practice of scraping off small areas of the thin layer and measuring their radioactivity in a liquid scintillation counter. The transport mechanism in its most recent version allows two-dimensional automatic scanning, with continuous or stepwise advance, and correspondingly analogous or digital registration. A dot recording allows simple visualization of the radiochromatogram, similar to an autoradiograph, however, in a much shorter time. Small available diaphragm openings down to 0.2 × 2 mm make the instrument useful also for histological preparations and small animal scanning. The instrument is also used for evaluating doubly labeled chromatograms, for instance separate measurement of tritium and $^{14}C$ activity in one chromatogram. (auth)

**32598** A 4 π ANTICOINCIDENCE ARRANGEMENT FOR MEASUREMENTS OF BETA-RAY-EMITTING ISOTOPES. Srdoc, D. (Inst. Ruder Boskovic, Zagreb). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/72, 11p. (CONF-650507-34). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

A 4π anticoincidence, low-background counting system consisting of two specially designed parallel plate counters and a bridge anticoincidence circuit is described. Each counter is of a flat, mica window pancake type. The diameter of the counters is much larger than the gap between the plates. Good counting properties are obtained in spite of the unusual counter geometry, owing to the flexibility of the counter shape design when a neon-halogen mixture is used. The counters are so arranged that both windows face the sample, leaving a narrow slit for the sample holder. The sample is spread on a thin metalized plastic film. The pulses from both counters due to beta particles coming from the sample are recorded, giving a 4 π counting geometry. The pulses due to cosmic particles triggering both counters simultaneously cancel out in a simple bridge anticoincidence arrangement, thus eliminating the need for an electronic circuit. Furthermore, the parallel plate counters used for beta particle counting possess a markedly reduced sensitivity to gamma rays near the threshold voltage, resulting in a further lowering of the background. Sources of beta particles of higher energies, as well as gamma sources, can also be measured by the described system, because in the proposed geometry there is no possibility of triggering both counters simultaneously, as is the case with the conventional guard counter arrangements. (auth)

**32599** MEASUREMENT OF GAMMA-ACTIVITY IN LARGE MEDICAL OR BIOLOGICAL SAMPLES OF LOW SPECIFIC ACTIVITY. le Gallic, Y.; Legrand, J.; Biettmann, D.; Travers, J. (Centre d'Etudes Nucleaires, Saclay, France). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-61/63, 16p. (In French) (CONF-650507-11). ORINS

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Two spectrometer arrangements, one in coincidence and the other in anticoincidence, devised for gamma spectrometry at very low activity levels are described. The $8\frac{1}{2}$ in. × $7\frac{1}{2}$ in. NaI(Tl) scintillation crystal used in this spectrometer was specially designed to have a minimum background, and has a well with a capacity of about 500 ml. The spectrometer, of which the measurement threshold varies from $10^{-7}$ to $10^{-8}$ μC/ml according to the radionuclides concerned, permits the use of tracer techniques at levels never before reached. Its resolution also permits the radioanalysis and quantitative determination of mixtures of gamma-emitting radionuclides. In addition, the device makes possible the study of natural radioisotopes with very low specific activity, such as $^{40}K$, $^{138}La$, and $^{176}Lu$, as well as the determination of certain disintegration schemes about which little is yet known, but a knowledge of which is essential to the correct application of biological and medical research in number of fields. (auth)

**32600** IMPROVEMENTS IN OR RELATING TO SILICON SEMICONDUCTORS. Messier, Jean (to Commissariat à l'Énergie Atomique). British Patent 979,844. Jan. 6, 1965. Priority date Nov. 24, 1961, France.

A process is described for the production of a semiconductor device that includes a silicon diode obtained by diffusion of donor and acceptor materials into the regions adjacent to parallel faces of a plate that includes an intrinsic Si semiconductor element having a resistivity of at least 5000 Ω cm. The intrinsic Si is prepared from low p conductivity Si formed by the floating zone method and subjected to thermal neutron bombardment. The irradiated Si is annealed for about 12 hr at 550°C. A heat treatment is necessary to cause the activator materials (donor and acceptor) to diffuse into the Si plate. The heat treatment is carried out in a neutral atmosphere followed by a cooling stage in which the temperature is reduced by at least 5° C/min. The resulting semiconductor device withstands a high reverse voltage, and is useful in ionization and nuclear radiation detectors. (B.L.M.)

**32601** A DEVICE FOR THE MEASUREMENT OF NEUTRON FLUX. (to Nihon Genshiryoku Kenyujo). British Patent 979,959. Jan. 6, 1965. Priority date Oct. 11, 1962, Japan.

A method and device are provided for delivering a desired neutron flux to a neutron detector. The device includes a container of neutron-absorber fluid located at a position outside the detector for shielding neutrons and fixed in a neutron generator. The neutron flux reaching the detector is controlled to the desired value by controlling the content, pressure, species, and all other factors that affect the neutron absorption cross section of the fluid absorber. (B.L.M.)

**32602** IMPROVEMENTS IN OR RELATING TO APPARATUS FOR MEASURING RADIATION. (to Philips Electronic and Associated Industries Ltd.). British Patent 980,163. Jan. 13, 1965. Priority date Oct. 17, 1962, Netherlands.

An apparatus for measuring radiation includes two pulse-producing detectors for supplying pulses through two electronic switches in a first position to two counters. When the switches are in the second position, a pulse generator supplies pulses to the two counters so that no pulses are supplied to the counters from the detectors. Means are included for stopping the supply of pulses from the pulse generator as soon as the second counter has reached a predetermined counting position. The first counter gives an indication of the difference in the radiation detected by the two detectors during the predetermined time interval. Switching clock means are provided in order that the time can be adjusted during which the switches are in the first position and automatically change the switches to the second position after this period of time. (B.L.M.)

**32603** DOSIMETER FOR THE MEASUREMENT OF ROENTGEN, GAMMA OR NEUTRON RAYS. Hosemann, Rolf; Warrikhoff, Harald; Basler, Guenter (to Max-Planck-Gesellschaft zur Forderung der Wissenschaften e.v.). German Patent 1,187,329. Feb. 18, 1965. Filed Dec. 27, 1960.

A dosimeter for the measurement of x, gamma or neutron radiation is designed which comprises a string loop electrometer which measures the emf generated by the irradiation of the two detector electrodes. In order to improve the initial sensibility of the electrometer which has a quadratic characteristic additional auxiliary electrodes are mounted on the outer electrometer electrode protruding against the string. The two auxiliary electrodes are disposed and shaped in such a way that the vertex of the string passes into a slot formed by these two electrodes. For further improvement the electrodes are coated by sensitized layers. (Gmelin Inst.)

**32604** CUPPED COUNTER FOR MEASURING THE RADIOACTIVITY OF FLUIDS, VAPORS, OR GASES. Werner Reichel (to VEB Vakutronik Dresden). German

Patent 1,188,219. Mar. 4, 1965. Filed May 20, 1960.

A cupped flow counter is described which comprises a cylindrical counter tube vertically disposed in a cup and melted into the bottom of the cup, and ground inner cone at the upper, open end of the cup. A case comprising an inlet for the fluid to be measured is provided with a ground outer cone which is releasable fitted into the cone of the cup. (Gmelin Inst.)

**32605** CASE FOR PHOSPHOR GLASS DOSIMETER. Horner, Charles R.; Gray, William F. (to U. S. Navy). U. S. Patent 3,169,188. Feb. 9, 1965. Filed Aug. 18, 1952.

A small phosphor glass is mounted within a casing in such a manner that radiation may strike either the front or back face. The casing consists of a plastic cup and a plastic base removably joined together in a water-tight manner. Lead shields inside the casing filter out undesired radiation. Provision is made for exposing the dosimeter to ultraviolet light when a reading is desired and for the resulting fluorescent light to pass out of the casing to be measured in any suitable way. (A.G.W.)

**32606** TELLURIUM DOSIMETER. Roth, Harold; Teutsch, Werner B.; van Lint, Victor A. J. (to General Dynamics Corp.). U. S. Patent 3,171,026. Feb. 23, 1965. Filed Mar. 8, 1961.

The device patented monitors total radiation received by measuring the effect of radiation on electrical conductivity of a highly purified Te specimen. The specimen maintains its radioinduced conductivity as long as it is maintained at a temperature below its electrical annealing temperature, about 90°K. The device may be reused by heating the specimen above its annealing temperature and then recooling. Means for maintaining the specimen at liquid-nitrogen temperature and for measuring the electrical conductivity are provided. (A.G.W.)

**32607** METHOD FOR STABILIZING COLOR OF GLASS EXPOSED TO HIGH LEVEL X-RADIATION. Hood, Harrison P. (to Corning Glass Works). U. S. Patent 3,173,850. Mar. 16, 1965. Filed Nov. 10, 1955.

A glass intended for use as a roentgenometer acquires a purple coloration, which does not fade and is substantially unaffected by heat up to 300°C, when exposed to bactericidal radiations consisting essentially of x radiation shorter than about 4 Å and at an energy level of at least about 100,000 R. The glass is a Pb-free silicate glass containing 1-5% by weight of antimony oxides computed as $Sb_2O_3$ and 0.1-0.8% by weight of manganese oxides computed as $MnO_2$. (A.G.W.)

**32608** SINGLE CHANNEL REMOTE RADIATION MONITOR WITH MEANS TO PREVENT DRIFT IN THE PHOTOMULTIPLIER TUBE. Eberline, Howard C. (to Eberline Instrument Corp.). U. S. Patent 3,174,040. Mar. 16, 1965. Filed June 12, 1961.

The instrument described is adapted to monitor radiation at a remote location, to visually indicate and to record the level, and to operate an alarm if the level exceeds a predetermined maximum. The monitor circuit includes a d-c steady power supply, a range switch, and a detector of the photomultiplier-scintillation crystal type. The output from the detector is connected to a meter to operate an indicating needle. The needle is locked in at each reading until released. Provision is made to operate the photomultiplier tube, the needle release, and the recorder at predetermined intervals. (A.G.W.)

**32609** METHOD AND APPARATUS FOR DETECTING X-RAYS. Schumacher, Wilhelm W. B. (to Ontario Research Foundation). U. S. Patent 3,175,083. Mar. 23, 1965. Filed Dec. 14, 1960.

Apparatus and a method for detecting and analyzing x rays within the complete x-ray spectrum are described. A beam of x rays is directed against a target positioned in an evacuated chamber. The photoelectrons emitted are accelerated through the evacuated chamber toward an electron detector. The target structure used depends on the nature of the measurement to be made. It may be a single target, a series of targets one behind the other, or several individual targets, each of a different element and each irradiated separately. (A.G.W.)

**32610** RADIATION DETECTION SYSTEM WITH THE IONIZATION CHAMBER AND OTHER SENSITIVE PARTS OF THE SYSTEM INCLOSED IN AN ATMOSPHERE OF INERT DRY GAS. Scherbatskoy, Serge A. U. S. Patent 3,177,363. Apr. 6, 1965. Filed May 26, 1961.

By enclosing the sensitive parts of a radiation detection system in an atmosphere of inert dry gas, a leakage resistance of the order of $10^{18}$ ohms can be obtained and maintained. The detector consists of an ionization chamber whose output is in the form of electric voltage pulses. The intensity of the field being measured is indicated by changes in the repetition rate of the pulses rather than by the magnitude of the output voltage. Measurements are thus independent of changes in supply voltage, and calibration stability is increased. (A.G.W.)

**32611** MECHANICALLY MODULATED NEUTRON ION CHAMBER. Thomas, Harold A. (to General Dynamics Corp.). U. S. Patent 3,182,219. May 4, 1965. Filed Nov. 21, 1960.

Apparatus is provided for selectively detecting neutron flux emanating from a source of neutron and gamma radiation by the production of an alternating signal that is a direct representation of the neutron radiation. A gas-filled chamber situated adjacent to the source of radiation has a neutron-absorbing shield formed about a substantial portion of its outer surface. The unshielded portion is provided with a segmented surface consisting of neutron absorbing and neutron passing materials. A selectively movable member has a corresponding segmented construction and is situated adjacent to that of the unshielded portion of the chamber. Movement of the member to alternately advance the radiation passing segments of the member into and out of alignment with the neutron passing segments of the unshielded portion of the chamber varies the density of the neutron flux passing from the source into the chamber from zero to a maximum value. The ion current created in the chamber as a result of entering radiation contains a constant component resulting from the gamma radiation and a component that varies from a minimum to a maximum value resulting from the modulated neutron radiation. The varying component of the current is a measure of the neutron flux density and may be readily detected, amplified, and recorded by conventional means that function in conjunction with the chamber. (B.L.M.)

**32612** DETECTOR FOR RADIOACTIVE HYDROGEN GAS. Maggio, Ralph C.; Christianson, Charles. U. S. Patent 3,183,389. May 11, 1965. Filed Dec. 27, 1960.

A device is patented for detecting and measuring uncombined radioactive hydrogen in other gases. The device comprises a closed container, and a portion of the container wall is made of unglazed porous ceramic that is relatively permeable to diffusion into the container of the radioactive hydrogen and is comparatively impermeable to other gases. The portion of the container of unglazed ceramic is lined on the inside with a thin continuous imperforate layer of a metal that is permeable to hydrogen diffusion and not to other gases. Heater wire is distributed around the outside of the metal liner and is embedded in the ceramic. Electrode means are provided in the container for use in establishing an electric field in the container. A counting gas is confined in the container at ambient pressure. In operation, the unit is supported in a suspect atmospheric environment. The unit is operated at a temperature at which it was previously calibrated in chambers containing known concentrations of $H_2$, and a thermostat automatically maintains the unit at the selected temperature, e.g., below 300°C if a Pd liner is used and a much higher temperature if a Ni one is used. When a unidirectional electric field is established in the container and radioactive $H_2$ outside diffuses through the container wall, pulses of current flow occur along the electric field due to ionization pulses caused by the diffused $H_2$. (B.L.M.)

# Radiation Effects

**32613** (AD-608960) EXPLORATORY DEVELOPMENT OF THE Q-FACTOR TECHNIQUE. Report No. 2557. Progress Letter No. 1 Monthly Report for February 1964. Frank, Max (Bendix Corp., Southfield, Mich. Research Labs. Div.). Mar. 10, 1964. Contract AF29 (601)-6316. 29p. $2.00(CFSTI).

The Q-factor technique is a method of describing bipolar transistor gain as a function of the radiation exposure of the device. The ultimate goal of the Q-factor approach is to provide an accurate means of predicting transistor gain as a function of radiation type for various temperature, operating, and measurement conditions. An experimental-analytical effort is made to screen and acquire the qualitative influences of the intermixed variables. The experimental phases consist of a series of gamma and two nuclear reactor tests with x irradiation used to assist in separating surface and bulk damage effects. (auth)

**32614** (AD-609932) RADIATION EFFECTS ON FIELD EFFECT TRANSISTORS. PART I. Hunter, Edwin T. (Army Electronics Labs., Fort Monmouth, N. J.). June 1964. 31p. (ECOM-2462(Pt.I)). $2.00(CFSTI).

Several varieties of junction gate field-effect transistors were studied to determine transient drain currents upon exposure to single pulses of bremsstrahlung. Data obtained indicate that the transient currents are dependent on (a) the junction volume and (b) the transconductance. At low gate voltages, where the transconductance is closed to its maximum value, the transient $I_D$ is small compared to the operating $I_D$. However, at gate voltages near pinch-off, the transient $I_D$ is much larger than the operating $I_D$ and may present problems in switching applications. (auth)

**32615** (NAA-SR-10856) COMPARISON OF NEUTRON AND GAMMA RADIATION DAMAGE IN SEMICONDUCTORS. Robinson, M. N. (Atomics International, Canoga Park, Calif.). June 10, 1965. Contract AT(11-1)-Gen-8. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Calculations are presented which relate the damages produced in silicon semiconductors by SNAP reactor neutrons and gammas. Design dose levels are derived for SNAP payload components, consistent both with this relation and with the necessity of minimizing shield weight. (auth)

**32616** (NASA-TN-D-2817) EFFECT OF 40-Mev PROTONS ON SEMICONDUCTORS AS DETERMINED WITH AN IMPROVED METHOD OF MEASURING DIFFUSION LENGTH OF MINORITY CARRIERS. Beatty, Marvin E.; Hill, Gerald F. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). June 1965. 20p. $1.00(CFSTI).

Radiation-induced changes in semiconductor materials from 40-Mev protons were observed during irradiation. These changes were determined by the application of an improved infrared method for obtaining the diffusion length of the minority carrier in the semiconductor material. The semiconductor materials investigated comprised the base region of p-n junction photovoltaic devices. The diffusion length and lifetime before, during, and after irradiation are presented in both graphic and tabular form as a function of integrated proton flux. The data obtained show that very short carrier lifetimes may be calculated by employing the infrared method. (auth)

**32617** (NP-15091) RADIATION DAMAGE TO SEMICONDUCTORS BY HIGH-ENERGY ELECTRON AND PROTON RADIATION. Progress Report, September 15, 1964–March 15, 1965. Corelli, John C. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). 74p.

Progress is reported on the studies of the electron-irradiation effects on the carrier lifetime and electric resistivity of Ge, the infrared absorption spectra of single-crystal and zone-refined Si, the photoconductivity spectra of zone-refined Si, and the low temperature annealing of electric properties of zone-refined Si. (W.L.G.)

**32618** (SC-RR-65-224) REDUCTION OF 600 2N1051 TRANSISTORS TO A SPECIFIED GAIN BY NEUTRON BOMBARDMENT. Tapp, C. M.; Phillips, A. R. (Sandia Corp., Albuquerque, N. Mex.). June 1965. Contract AT(29-1)-789. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Six hundred transistors of initial gain distribution of $45 \rightarrow \approx 100$ were reduced to a distribution of $40 \rightarrow 45$ in 10 irradiation steps. (auth)

**32619** EFFECTS OF ELECTRON IRRADIATION ON N AND P SILICON SOLAR CELLS. Luft, Werner (TRW Space Tech. Labs., Redondo Beach, Calif.). Advan. Energy Conversion, 5: 21-41(May 1965).

Radiation tests on bare N/P silicon solar cells and solar cells with various cover materials were performed with 1-Mev electrons for integrated fluxes up to $10^{16}$ e/cm$^2$. The effect of electron irradiation upon the physical, electrical, optical, and thermal characteristics of the cells were analyzed and are presented in parametric form wherever practical. In particular, the changes with electron flux in the electrical output, and the temperature coefficients of the electrical output, as well as the effect of the angle of incident radiation upon the output, were investigated. The variations of spectral transmittance of cover materials and the spectral reflectance at angles of incidence between 0 and 75° were measured, and the data were compared to the electrical measurements results. The solar absorptance as a function of angle of incidence and the hemispherical emittance were calculated. All electrical measurements were performed under illumination closely approximating the spectrum of solar irradiation in outer space and at the intensity of the solar constant. This is of particular importance when studying the effects of charged particle radiation, since the data thus obtained can be directly utilized for spacecraft solar array design. (auth)

**32620** STUDY OF PHOTOMULTIPLIER OPERATION AFTER HIGH GAMMA-RAY DOSE IRRADIATION. Henrich, H.-J. (Institut fuer Angewandte Physik ker Reinststoffe der DAW, Forschungsgemeinschaft, Dresden). Kernenergie, 8: 242-9(Apr. 1965). (In German)

In continuing studies of high-energy radiation effects on electronic construction elements, the behavior of the M 12 FS type photomultiplier was determined after gamma irradiation. Some characteristic parameters of the photomultiplier as well as its operation ability in energy measurement and for particle counting were studied as functions of irradiation dose. The maximum irradiation dose of $^{60}$Co gamma rays amounted to $10^7$ R. (auth)

**32621** EFFECTS OF $^{60}$Co GAMMA-RAYS ON PARAMETERS OF A PHOTOMULTIPLIER. Pertsev, A. N.; Pisarevskii, A. N.; Soshin, L. D. (Belorussian State Univ., USSR). Pribory i Tekhn. Eksperim., No. 2, 146-9(Mar. Apr. 1965). (In Russian)

The effect of the irradiation of a photomultiplier with $^{60}$Co $\gamma$ rays on the subsequent operation of the photomultiplier was investigated. It was shown that reversible modification of the sensitivity of the photocathode and the multiplying coefficient of the photomultiplier occurred. (tr-auth)

**32622** EFFECTS OF ELECTRON IRRADIATION ON METAL-OXIDE SEMICONDUCTOR TRANSISTORS. Stanley, Alan G. (Massachusetts Inst. of Tech., Cambridge). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 627-8(June 1965).

The effects of electron irradiation on commercially available p-channel metal-oxide semiconductor field-effect transistors designed for enhancement mode operation. The devices were turned off by connecting the gate to the grounded source through a 100-M Ω resistor. At a total dose of about $5 \times 10^{12}$ e/cm$^2$, the leakage current

started to rise. It saturated between 20 and 40 μA at a total dose of $10^{14}$ e/cm$^2$. The turn-on voltage increased with total electron flux. At a total dose of $5 \times 10^{14}$ e/cm$^2$ it was no longer possible to turn on the devices. These results were explained by the formation of an N-type inversion layer formed within the p-type drain region under the oxide. The gate leakage current did not change significantly during irradiation. (M.C.G.)

# ISOTOPE TECHNOLOGY

## Industrial Applications

**32623** (AD-610723) IRRADIATION OF WHITE POTATOES FOR SPROUT INHIBITION WITH COBALT-60. The Army Petition for Clearance and Approval to the Food and Drug Administration. (Quartermaster Research and Engineering Center, Natick, Mass.). [1963]. 47p. $2.00 (CFSTI).

Data are reviewed from research studies on the influence of $\gamma$ radiation on sprout inhibition of white potatoes. It is pointed out that the demand for an improved sprout inhibition process is related to the losses incurred through sprouting and internal softening or because of the inefficiency of current storage and chemical methods. Data are included from studies on the effects of $\gamma$ radiation on the physiology, biochemistry, and organoleptic characteristics of the stored tubers of various varieties, and the effects of pre- and post-irradiation handling methods on product quality. It is concluded that $\gamma$ irradiation of potatoes is an efficient sprout inhibitor. Gamma doses of 7,500 rad ±30%, effectively inhibit sprouting for all practical purposes and do not materially alter the physiology of the potato or the biochemistry of potato constituents. (44 references.) (C.H.)

**32624** (EUR-2402.f) ETUDE SUR LES METHODES D'IDENTIFICATION DES DENREES ALIMENTAIRES IRRADIEES. (Study on the Identification Methods of Irradiated Foodstuffs). Lafontaine, A.; Bugyaki, L. (European Atomic Energy Community). Apr. 1965. 30p. Dep.(mn).

After a brief review of the economic and health considerations involved in the preservation of foodstuffs, various methods generally used are mentioned, and the principles which led to the proposal to use ionizing radiation are set out. It is pointed out that uncertainty as to the wholesomeness of irradiated foods still exists in scientific circles in spite of extensive research. Nevertheless, certain countries have already permitted several kinds of irradiated food to be distributed for consumption. There are grounds to expect that the marked zone for certain of these products will not stop at the national frontiers. The problem therefore arises, at both the national and international level of foodstuff controls, of how to identify irradiated products and how to ascertain the dose employed for irradiation. Methods suitable for such a purpose are listed. They include measurement of the paramagnetic state of the atom, electrophoresis, measurement of the oxide-reduction potential, polarography, chromatography, spectrophotometry, colorimetry, microscopic examination of the tissues, immunological changes, microbiology, deterioration of the packaging and changes in the organoleptic characteristics. (EURATOM)

**32625** (KLX-1869) PRELIMINARY DESIGN REPORT—TITLE I ON BULK GRAIN IRRADIATOR. (Vitro Engineering Co., New York, N. Y.). Jan. 27, 1965. Contract AT(30-1)-3389. 68p. Dep.; $3.00(cy), 2(mn) (CFSTI).

The Bulk Grain Irradiator will be capable of delivering gamma radiation doses in the disinfestation range (approximately 25,000 rads) to handle 5,000 lb/hr of grain at this dose. The bulk grain will be loaded into a hopper outside the irradiator from whence it will be carried by conveying equipment through the irradiation section. The grain will leave the irradiation cell by means of a pressurized air system. The bulk grain may be stored in any of the bins provided by the USDA located either inside or outside of the building. It also may be delivered directly into railway cars located at the nearby spur. In addition, packages and bags of a large range of products, including dried fruit, peanuts, cereals, grains and flour, may be processed in the section of the irradiator designed for package handling. The packaged products will be arranged in aluminum carriers and loaded automatically into the package handling section of the irradiator from the interior of the building. Work space and storage space for the packaged product are provided in that vicinity. It is expected that initially packaged products will be irradiated. Bulk grain irradiation is not likely to occur in substantial volume until approximately a year after the completion of the facility. The same source material will be used for both the bulk grain and the package handling part of the irradiator. (auth)

**32626** (NYO-3461-1) THE DETERMINATION OF THE WHOLESOMENESS OF IRRADIATED PASTEURIZED CLAMS. Period Covered: September 1964–April 1965. Elwood F. Reber (Massachusetts Univ., Amherst. School of Home Economics). May 1965. Contract AT(30-1)-3461-1. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Rats were maintained on diets containing radiation processed clams (mya arenaria) for over a year. Hematological, enzyme, and gross pathological data on two generations showed no adverse effects of the irradiated clams. No difference was found in the protein quality of raw, nonirradiated, freeze-dehydrated flounder and freeze-dehydrated flounder irradiated with 600,000 rads $\gamma$. Preliminary data included from studies on the wholesomeness of radiation processed shrimp. (C.H.)

**32627** GAMMA IRRADIATION OF ONION BULBS TO INHIBIT SPROUTING. II. BROWNING PHENOMENON IN INNER BUDS OF IRRADIATED ONION BULBS, AND A METHOD OF EARLY DETECTION FOR INHIBITION OF SPROUTING. Hori, Shiro; Kawasaki, Toshio (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 90-2(Mzr. 1965).

Onion bulbs (Senshu-Nakadaka), were exposed to $^{60}$Co gamma rays on July 10, 1964, and were tested for inhibition of sprouting during storage under natural conditions. Sprouting of onion bulbs was inhibited at doses of 2000 and 3000 R (dose rate was 810 R per hour), and affected slightly at a dose rate of 50 R per hour even when the total dose was 3000 R. The appearance of browning in inner buds was correlated with the inhibition of sprouting. A method of early detection of inhibition of sprouting is reported. (auth)

**32628** IRRADIATION OF FOOD. Brit. Med. J., 1: 1330(May 23, 1964).

A brief discussion of radiopasteurization and radiosterilization of food that deals mainly with doses used for various commodities and possible future developments is given. The use of the process to sterilize foods such as meat and fish to allow storage at room temperature is limited, because the high dose of radiation (between 4 and 5 Mrad) required to kill Clostridium botulinum causes an unpleasant odor and flavor to develop in the food. Process aimed at increasing the refrigeration life at 0-4°C of such foods, when the dose required lies in the range 0.3-0.6 Mrad and the food is unaffected, are much more promising. The use of radiation to eliminate Salmonella food-poisoning organisms is of particular interest. The dose required is about 0.5 Mrad, so there is little effect on the products themselves, particularly if frozen. The process is suitable for the treatment of frozen whole egg in cans. Problems still remain with commodities such as frozen packed boneless horsemeat imported for pet food, since much of this meat is contaminated with salmonellae. Also discussed are questions as to whether the treated food is safe for consumption, whether any toxic compounds are formed, and whether there are any microbiological hazards. So far no evidence of toxicity has been found in animal experiments. The losses in nutritive value, particularly at sterilizing doses, are similar to those from cooking. (TCO)

**32629** PROCESSING OF FOODS TO COME—IRRADIATION, FREEZE-DRYING, FORMAL FLAVOR CONTROL. Hospitals, 38: 103-5(Jan. 16, 1964).

Progress in research in radiation processing of food at the food radiation lab of the U. S. Army Natick (Mass.) Laboratories is reported. Two methods of radiation are being studied. $\gamma$ rays from $^{60}$Co and $\beta$ rays from a linear accelerator. Distinction is made between light doses of radiation to extend shelf life and refrigeration life of certain foods and sterilizing doses of radiation which will preserve foods for a longer period. Lower doses of radiation for insect control, sprout inhibition, and pasteurization create fewer problems of flavor change. White potatoes given a light dose of radiation will keep from 12 to 18 months. Irradiated citrus fruits have a longer shelf life. A light dose of radiation disinfects wheat of weevils and other insects. The market life of fresh strawberries can be extended to weeks rather than days by radiation treatment. The fishing industry may use irradiation aboard ship to extend the storage life of seafood. Research has been mainly on sterilizing doses of radiation. Studies on sterilizing radiation has been made mostly on meat products, because most problems of acceptability in foods for the front lines were concerned with meats. Exhaustive studies of the safety of such products have established that no harmful effects to man were caused by ingestion of irradiated foods. (TCO)

**32630** THE POSSIBILITY OF USING THE $Co^{60}$ RADIOISOTOPE AGAINST GRAIN STORAGE INSECTS. Blazek, J.; Dockal, J.; Kolin, J. Mlynsko-Pekarsky Prumysl, 10: 436-9(Oct. 1964). (In Czech)

Containers with grain, to which were added 30 live grain beetles (Calandra granaria L.) and grain that had beetle eggs, were exposed to various doses of $^{60}$Co $\gamma$ radiation. A 5,000-rad dose was sufficient to exterminate the beetles, their eggs, and larvae. Three arrangements for irradiation of grain are described. In 2 cases, the grain would be irradiated as it passed slowly into the silo. The third, and recommended arrangement, involved the placement of a metal tube along the shaft of the silo. The source would be suspended inside the tube on a cord, which could be unwound and wound by a motor at the top of the tube or pipe. The radiation source could be raised or lowered to obtain the desired exposure. (OID)

**32631** ATOMIC ENERGY IN RADIATION DAMAGE TO LIVING ORGANISMS. Ksiazek, Jan. Postepy Nauk Rolniczych, 12: 131-5(Jan.-Feb. 1965). (In Polish)

The useful effects of sterilizing and pasteurizing doses of radiation are reviewed. Topics discussed include: the physical properties of ionizing radiation; radiation-dose damage; disinfection of grains, retardation of sprouting and germination of seed-type foods; sterilization of insects (males) and insect population control; changes in susceptibility to disease due to induced mutations; and use of radioisotopes in biological research. (H.G.D.)

**32632** ISOTOPES AND RADIATION TECHNOLOGY. Volume 2, Number 3. Baker, P. S.; Lafferty, Robert H., Jr.; Gerrard, Martha, eds. (Oak Ridge National Lab., Tenn.). Spring 1965. $0.55 (GPO) (domestic), $0.70 (GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 130p. Dep.

Reviews, abstracts, and extracts are presented of papers from the 1964 Geneva conference which treated topics in isotope production and application. Process radiation, source, and isotopic power developments and applications in medicine, biology, and agriculture are covered. (D.L.C.)

**32633** INDUSTRIAL RADIOISOTOPE ECONOMICS. Findings of the Study Group Meeting on Radioisotope Economics held in Vienna, 16-20 March 1964. (International Atomic Energy Agency, Vienna (Austria)). Technical Reports Series No. 40. 1965. 582p. (STI/DOC/10/40). $11.50; S 241.50 (£3.9.0; F.Fr. 46,-; DM 40.25 (IAEA)).

An international survey was carried out on the use of radioisotopes in industry, and reports from 25 countries are given on the use and economic advantages in these countries. Technical and economic summaries are given, and a panel discussion on obstacles to increased use of radioisotopes is included. (D.L.C.)

**32634** RADIATION PRESERVATION OF FOODS. Proceedings of an International Conference, Boston, Mass., Sept. 27-30, 1964. Washington, D. C., National Academy of Sciences—National Research Council, 1965. 435p. $9.00. (NAS-NRC-Pub. 1273; CONF-640909)

Thirty-one papers were presented on various aspects of food radiopreservation including: technological aspects, source facilities and technology, wholesomeness and food legislation, and microbiological aspects. Abstracts were prepared for 20 papers. Abstracts of 11 papers appeared previously in NSA as: 19: 15943, 15962, 15963, 20420, 20421, 20422, 20423, 20424, 20425, 22838, and 30607. (H.G.D.)

*For abstracts of individual papers see: 31695, 32635, 32636, 32637, 32638, 32639, 32640, 32641, 32642, 32643, 32644, 32645, 32646, 32647, 32648, 32649, 32650, 32651, 32652, and 32653.*

**32635** NEED FOR INTERNATIONAL COOPERATION. Goresline, Harry E. (FAO/IAEA, Vienna). pp 17-21 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Reasons supporting international cooperation in radiopreservation of foods are discussed. Sharing technology is more economical on a regional basis than on political foundations. Another phase of international flavor in food radiopreservation programs is the scope of trade lanes. Control of food contaminants must cross political boundaries to be successful. Training programs of international agencies in the area of food processing and handling are cited as a facet in which cooperation is already practiced. (H.G.D.)

**32636** PROSPECTS FOR RADIATION PRESERVATION OF FOODS IN BRITAIN. Neal, W. T. L. (Ministry of Agriculture, Fisheries, and Food, London). pp 25-30 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

The feasibility of food radiopreservation on a commercial scale in Great Britain is considered, and it is concluded that it is extremely unlikely that any commercial undertaking would commit itself to the high capital expenditure involved in launching an irradiated food on the market. It is pointed out, however, that no legal impediments exist at the present time. One application of food irradiation for which plans are well advanced is the irradiation of imported frozen horse meat. Other animal foodstuffs that are imported and that must be treated for Salmonella, a process which under present practice lowers the protein value of the commodities, are discussed in view of radiopreservation advantages. (H.G.D.)

**32637** EUROPEAN RADIATION PRESERVATION OF FRUITS AND VEGETABLES. de Zeeuw, D. (EURATOM-ITAL, Wageningen, Netherlands). pp 31-7 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Arguments in favoring radiopreservation of fruits and vegetables are presented. Functions of food processing pilot plants are discussed. (H.G.D.)

**32638** IRRADIATION OF FRUITS AND VEGETABLES. Maxie, E. C.; Sommer, N. F. (Univ. of California, Davis). pp 39-52 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Major developments in food irradiation technology at the University of California are presented; critical features of post-harvest research as they may apply to the irradiation process are emphasized; and current status of the program is indicated. Research suggests that irradiation technology is most likely to develop with fruits that are harvested partially or fully ripe and thus that have a relatively short post-harvest life. At present the most promising fruit is the strawberry. However, radiopres-

ervation of other fruits may become feasible in the future. (H.G.D.)

**32639** RADIATION PRESERVATION OF FISH OF THE NORTHWEST ATLANTIC AND THE GREAT LAKES. Ronsivalli, L. J. (Bureau of Commercial Fisheries, Gloucester, Mass.); Steinberg, M. A.; Seagram, H. L. pp 69-80 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Research conducted at two Bureau of Commercial Fisheries installations is reported. Main objectives of the scientists in these laboratories were: to determine the feasibility of using the process of irradiation on the economically important species of fish within the various regions served by the laboratories, and to determine the optimum radiation dose for each species. Results indicate the following: cobalt-60 radiation at pasteurizing doses has promising application in the fishing industry; the shelf life of the products tested was increased at least twofold; acceptability of the product was equivalent to that of fresh or fresh-frozen products, or nearly so, throughout storage life; optimum doses were less than 600,000 rads, but specific optimum doses were species-dependent; irradiation had no adverse effects on the nutritive quality of at least two species even when extremely high radiation doses were used; a variety of commercially available plastics were suitable for packaging irradiated foods; bacterial populations were reduced in irradiated fish by 99 per cent; volatile acid values correlate with organoleptic test results; and thiaminase had a low radioresistance at low doses. (H.G.D.)

**32640** RADIATION PRESERVATION OF HAM AND OTHER CURED MEATS. Hansen, Niels-Henrik (Danish Meat Research Inst., Roskilde, Denmark). pp81-5 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Work at the Danish Meat Research Institute has been centered on using a combination for thermal and ionizing radiation in food preservation. One advantage of the process is that the radiation dose required for canned meats is much less when used in combination with heat treatments. A combination treatment performed as a two-stage process in which the heat treatments precede the ionizing radiation kills the vegetative cells while activating the spores, making them less resistant to the ionizing radiations that follow. Since most canned cured-meat products will tolerate a moderate radiation dose without too serious effects on quality, it is suggested that applying irradiation as a supplement rather than as a substitute for thermal processing may greatly reduce the risk of botulism. (H.G.D.)

**32641** TROOP-ACCEPTANCE TESTING OF IRRADIATED FOODS. Hembree, Howard W.; Burt, Thomas B. (Army General Equipment Test Activity, Fort Lee, Va.). pp 109-19 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Irradiated and nonirradiated pork products, chicken, beef, and seafood were served as part of normal meals in garrison mess halls during a series of five soldier-consumer preference tests conducted at Fort Lee, Va., by the U. S. Army General Equipment Test Activity during the period June 1963 to June 1964. Items tested were subjected to sterilizing or pasteurizing doses of radiation at either the U. S. Army Natick Laboratories, Natick, Mass., or Louisiana State University, Baton Rouge, La., prior to shipment to Fort Lee for evaluation. The radiation-sterilized foods were held in storage at room temperature for periods of three to nine months prior to evaluation, and the radiation-pasteurized foods were held refrigerated for periods of 7 to 29 days prior to evaluation. The results showed that the nonirradiated control foods were preferred over their irradiated counterparts with the exception of irradiated pork chops and haddock, which were preferred equally to their nonirradiated counterparts. The preference scores given all the irradiated foods, with the possible exceptions of pork sausage and the high-dose radiation-sterilized shrimp, were sufficiently high for them to be considered acceptable as components of standard meals. The results also showed that radiation doses of 0.25 and 0.2 megarads will prolong the storage, at 33 to 35°F, of haddock for 14 days and shrimp for 7 days, respectively, without adversely affecting consumer preference. (auth)

**32642** CHEMICAL CHANGES IN IRRADIATED MEATS. Doty, D. M. (Fats and Proteins Research Foundation, Inc., Chicago). pp 121-5 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Since meat products contain large amounts of water, many of the reactions that occur when meat is subjected to ionizing radiations result from the action of free radicals that are formed during the radiolysis of water. When amino acids are irradiated in solution, the principal products formed are $NH_3$, keto acids, $H_2$, organic acids, and $CO_2$. Aromatic amino acids and methionine are particularly susceptible to destruction. Cysteine is oxidized to cystine, and some $H_2S$ is formed. When proteins in solution or biological tissue containing large amounts of protein are irradiated, the principal volatile products include hydrogen sulfide, mercaptans, sulfides, ammonia, amines, carbonyl compounds, hydrogen, and carbon dioxide. Some of these compounds undoubtedly contribute to the undesirable odor and flavor of irradiated meat. Although irradiation of lipids results in the formation of carbonyls and other oxidation products, these reaction products contribute very little to the undesirable flavor of irradiated meats. Exceptions to this statement include the development of rancid flavors when meat is irradiated and stored in the presence of oxygen, and the possible role of a spingomyelin or a similar phospholipid as a precursor for the less-volatile odor components of irradiated meat. Proteolytic enzymes are only partially destroyed by irradiation of meat at sterilizing dosages which allows undesirable proteolytic changes to occur when irradiated raw meat is stored. These changes can be prevented by heat inactivation (cooking) of the meat prior to irradiation. Experimentally, the proteolysis can be reduced by adjusting the pH of the meat to 4.0 to 4.5 prior to irradiation. Some of the myoglobin in red meat is oxidized to metmyoglobin during irradiation, and there is also a green pigment formed. Vitamins E and K are very susceptible to destruction by irradiation, and care must be taken to make sure that diets including irradiated foods contain adequate amounts of these vitamins. (auth)

**32643** ISOTOPIC SOURCES. Manowitz, Bernard (Brookhaven National Lab., Upton, N. Y.). pp 143-8 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Two cobalt-60 sources used for food radiopreservation, the U. S. Army Radiation Laboratory source and the Marine Products Development Irradiator, are described. Important characteristics of the sources that are discussed at length include self-absorption and dose uniformity in targets. (H.G.D.)

**32644** ASPECTS OF FOOD LEGISLATION IN CANADA RELATIVE TO WHOLESOMENESS. Morrell, C. A. (Dept. of National Health and Welfare, Ottawa). pp 199-203 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

The Canadian Food and Drugs Act is interpreted in terms of food irradiation. Particular emphasis is placed on a recent amendment to the act that includes food additive provisions. (H.G.D.)

**32645** SOME INTERNATIONAL ASPECTS OF WHOLESOMENESS OF IRRADIATED FOODS. Spaander, J. (National Inst. of Public Health, Netherlands). pp 205-8 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences—National Research Council, 1965.

Both international cooperation and trade would profit if general principles formulated for food legislation and for the establishment of consumption safety lead to a common approach in various countries of the world. Basic principles for irradiated food legislation established by the joint FAO/WHO/IAEA Expert Committee on the technical basis for legislation on irradiated food are presented. (H.G.D.)

**32646** THE POTENTIAL PROBLEMS OF TYPE-E BOTULISM IN RADIATION-PRESERVED SEAFOODS. Kempe, Lloyd L. (Univ. of Michigan, Ann Arbor). pp 211-15 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

Radiopreservation of fish must contend with the problem of Type-E botulism. Observations about Type-E that are pertinent to fish irradiation programs are discussed. The wide distribution of Type E spores makes the toxin a potential contaminant of fish processed anywhere in the United States. Secondly, when compared to other Clostridium botulinum spores, those of Type E are relatively easily inactivated by heat; however, there is growing evidence that they may be somewhat more resistant than previously believed. The activation of Type-E toxin by proteolytic enzymes causes even low titers to be dangerous to man. Finally, though Type-E spores and vegetative cells can be inactivated by ionizing radiations, the levels required for sterilization are much higher than fish pasteurization doses. (H.G.D.)

**32647** THE USE OF PASTEURIZING DOSES OF GAMMA RADIATION FOR THE DESTRUCTION OF SALMONELLAE AND OTHER ENTEROBACTERIACEAE IN SOME FOODS OF LOW WATER ACTIVITY. Mossel, D. A. A.; de Groot, A. P. (Central Inst. for Nutrition and Food Research T.N.O., Utrecht). pp 233-64 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

Results of irradiation of fish meal artificially inoculated with 10 different serotypes of Salmonella, three $H_2S$-negative strains included, are presented as log N versus dose (survivor) curves. In evaluating these data, difficulties were encountered because of two phenomena. Firstly, a considerable decrease in the number of viable cells, up to five decimal reductions, occurred upon inoculation of the dry fish meal, which was proved to be due to osmotic shock; also, a much slower dying off of viable salmonellae during subsequent storage was noticed. Secondly, rather frequent skips in the survivor curves, similar to those encountered in irradiation of spores of Bacillaceae, were observed. This prompted the introduction of a parameter similar to the F value used in thermobacteriology; it was named the most probably effective dose (MPED) of radiation. Examples of its calculation from experimentally determined degrees of bactericidal effect, from initial contamination, and from the required degree of security are given. Tentative wholesomeness data for irradiated fish meal were determined by feeding rats up to six months on diets containing 20 per cent fish meal irradiated at doses up to 1.5 megarads. No loss in the nutritive value of the protein was detected. Specific organ weights, as well as haematological, histological, enzymological, and fertility data revealed no signs of deleterious effects other than a slight leucopenia in some of the male animals fed fish meal irradiated at 1.5 megarads. At present these effects are being studied in all detail, using two-years' feeding studies with diets containing 35 per cent fish meal irradiated at 0.80 megarad, the maximal MPED having been established in the course of this investigation. In experiments with frozen chickens and ducks, all Enterobacteriaceae naturally contaminating such carcasses were chosen for ecological reasons as the parameter for the calculation of the MPED. Initial and surviving numbers of Enterobacteriaceae were determined by swabbing the entire outer and inner body surfaces of the birds with plugs of calcium alginate. In this way the MPED was found to be 0.4 megarad for four over-all decimal reductions. No organoleptically detectable side effects whatsoever have been observed by an expert taste panel in birds exposed to such a radiation treatment. The use of gamma radiation for the terminal decontamination of packaged fish meal seems rather promising for certain developing countries such as Peru and Chile, where recontamination of machine-dried meal occurs rather frequently, without any possibility for immediate improvement. Further study of the feasibility of radiation decontamination of frozen meats and game may be of interest to countries with a large animal industry mainly based on exportation, such as Argentina. (auth)

**32648** THE SALMONELLOSIS PROBLEM AND PROSPECTS FOR THE IRRADIATION TREATMENT OF FOODS. Thornley, M. J. (Low Temperature Research Station, Cambridge, Eng.). pp 265-8 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

Problems in using irradiation as a means of reducing Salmonella infections of food include: variation in radiosensitivity among serotypes; effects of chemical and physical factors on radiosensitivity; and determination of inactivation dose. The feasibility of using irradiation for Salmonella decontamination of frozen eggs and boneless meat is discussed. (H.G.D.)

**32649** VIRUSES AND RICKETTSIA IN FOODS AND THE POSSIBLE ROLE OF RADIATION PRESERVATION. Cliver, Dean O. (Univ. of Chicago). pp 269-80 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

It is known that viruses and rickettsia occasionally occur in the human food supply. It has not yet been possible to isolate these agents from foods involved in actual outbreaks of human disease, but methods for this purpose are under development. Foods have been shown to be the vehicles transmitting the viruses of poliomyelitis and infectious hepatitis in certain outbreaks, and it seems virtually certain that other viruses have been transmitted in the same way. It is also known that virus can be inactivated by the action of ionizing radiation upon the virus nucleic acid. No definite recommendations can be made until the levels at which contaminating viruses are likely to occur in foods are known. A safe dosage for the elimination of poliovirus, a relatively resistant species, from foods might be somewhat less than 5 megarads. Where significantly lower dosages than this are to be employed in treating foods, some study should be devoted to the public health significance of the possibility of inducing exotic mutants of the viruses that might be present. (auth)

**32650** WHOLESOMENESS, MICROBIOLOGICAL, AND BIOCHEMICAL ASPECTS OF THE AEC RADIATION PASTEURIZATION OF FOODS PROGRAM. Whitehair, Leo A. (Atomic Energy Commission, Washington, D. C.). pp 315-24 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

Current studies in the USAEC's Low-Dose Irradiated Food Program are summarized. Research in the program is concerned with wholesomeness, microbiological safety, and biochemistry of low-dose-irradiated foods. (H.G.D.)

**32651** THE CLEARANCE OF GAMMA-IRRADIATED WHEAT AND THE INTERNATIONAL IMPORTANCE OF THIS ACT. Nair, K. K. (Atomic Energy Establishment, Trombay, India); Brownell, Lloyd E. pp 325-59 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

Application of wheat irradiation to solution of food deficits is examined with particular emphasis on India. Experimental evidence of the wholesomeness and nutritional value and of the safety of gamma-irradiated wheat and wheat products is reviewed. Feeding, breeding, and growth studies with rats, mice, dogs, and chickens in the United States and abroad indicated that irradiated whole wheat and irradiated wheat products are wholesome and as nutritionally adequate as nonirradiated wheat and wheat products. Various studies with mammals, birds, and microörganisms

using radiation doses up to 45 million rads failed to indicate any evidence or induced toxicity in irradiated wheat and wheat products. Neither were any carcinogens demonstrated in irradiated foods and sterols from food using radiation levels of $10^5$ to $10^7$ rads. Theoretical calculations backed by experimental tests assured that no measurable amount of radioactivity is induced in wheat and wheat products by 20,000 to 50,000 rad doses of 0.5 to 2.2 Mev gamma rays. (H.G.D.)

**32652** AN EVALUATION OF DOSIMETRY PROCEDURES APPLICABLE FOR USE IN FOOD IRRADIATION. Holm, Niels W. (Army Natick Labs., Mass. and Danish AEC Research Establishment, Roso); Jarrett, Robert D. pp 361-82 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

Dosimetry procedures for the two types of radiation sources considered suitable for food irradiation, cobalt-60 sources and linear accelerators, are presented. A summarized introduction to the concepts and units of radiation dosimetry is included. (H.G.D.)

**32653** PRESERVATION OF MEATS BY STERILIZING DOSES OF IONIZING RADIATION. Wierbicki, Eugen; Simon, Morris; Josephson, Edward S. (Army Natick Labs., Mass.). pp 383-409 of Radiation Preservation of Foods. Washington, D. C., National Academy of Sciences — National Research Council, 1965.

The U. S. Army's Radiation Preservation of Foods Program has demonstrated that processing meats and poultry with sterilizing doses of radiation is feasible. It was demonstrated also that radiation-sterilized meats and poultry are wholesome for human consumption and are well accepted when served as components of regular meals. The clearance of the world's first radiation-sterilized food, bacon, by the U. S. Food and Drug Administration for unrestricted public consumption on February 8, 1963, is a forerunner of things to come. There is now considerable assurance that other meat products and poultry sterilized by ionizing radiation will win approval from the U. S. Food and Drug Administration and the U. S. Department of Agriculture. Industrial approval and utilization can be predicted by the end of this decade. (auth)

**32654** PORTABLE ULTRAVIOLET SOURCE PRODUCED BY A RADIOACTIVE SOURCE MATERIAL. Taylor, Randolph G. U. S. Patent 3,167,650. Jan. 26, 1965. Filed Sept. 11, 1962.

A portable ultraviolet lamp includes an elongated housing of radiation-absorptive material with means for holding a removable radioactive source such as $^{90}Sr$ or $^{55}Fe$ in one end of the housing. Suitable source materials emit x rays, pure alpha radiation, or pure beta radiation. The vacuum tight housing is filled with a gas such as He, $H_2$, Kr, Ar, Xe, $N_2$, or a mixture of these depending on the spectrum desired. The ultraviolet light is passed from the housing through suitable windows constructed of LiF, $CaF_2$, or NaBr or any other ultraviolet-transmitting material. The region of the spectrum to be isolated dictates the choice of window material. (B.L.M.)

# Power Application

*Refer also to abstract 32923.*

**32655** (MND-P-3005) RADIOISOTOPE-FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 8, October–December 1958. (Martin Co., Baltimore, Md. Nuclear Div.). Contract AT(30-3)-217. 72p. Dep. (mn); $3.00(cy), 2(mn) CFSTI.

Heat transfer and pressure drop studies of boiler tube configurations were conducted, and fabrication of the first isotope-fueled boiler began. Results of studies of the effects of calcining temperatures on compactibility and sinterability of ORNL-prepared cerous oxalate materials are given. Blending with $TiO_2$ and $CaCo_3$ increased sintered density. Testing of oxidation-resisting coatings for Ta continued. Static corrosion testing of stainless steel in inhibited molten Pb continued. Component development and test runs on rotating power conversion assemblies are described. Performance and capability of present components are summarized. A brief summary is given of progress in development of the vehicle to be used for transportation, servicing, and installation of the two half-boiler system. Test modules for InAs–GeTe and InSb–ZnSb junction pairs were designed and built. The thermal conductivity of $KTiO_3$ was measured as a function of He gas pressure. An inverter power supply was constructed which provided a regulated d-c output when operated from a thermoelectric generator. A thermoelectric generator using $^{210}Po$ was designed. Work on prototype and mockup designs of thermionic devices is described. (W.L.G.)

**32656** (MND-P-3006) RADIOISOTOPE-FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 9, January–March 1959. (Martin Co., Baltimore, Md. Nuclear Div.). Contract AT(30-3)-217. 106p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The re-entry hazards testing program was completed. The fuel element that was tested remained intact when impacting on all types of soil structure. Electrical Hg boilers that are similar to the isotope boiler were fabricated and subjected to preliminary dual boiler test operations. Additional cold fuel material was received and fuel pelleting experiments are continuing. The corrosion tests of oxidation resistant coatings in inhibited molten Pb are continuing. Colmonoy-5 coating has demonstrated the capability of withstanding molten Pb. Silver–lithium eutectic is being evaluated as a backup material for a thermal bond. Samples from solubility determinations of type 466 stainless steel, Nb, and Ta in Hg are being analyzed. The three-watt demonstration thermoelectric generator design was completed and is under assembly. A new handling concept covering shipping, handling, installation, and assembly procedures for the isotope-lead block and the boiler shield assembly was developed. (W.L.G.)

**32657** (MND-P-3007) RADIOISOTOPE-FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 10, April–June 1959. (Martin Co., Balitmore, Md. Nuclear Div.). Contract AT(30-3)-217. 163p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Progress is reported on the following tasks: over-all system design, boiler development, fuel development, materials corrosion program, power conversion system, ground test, thermoelectric power system, ground handling and transportation, thermionic conversion system, lower powered operational SNAP-IIIF, thermoelectric conversion and SNAP-VII system design and integration. (W.D.M.)

# Separation and Production

**See *also* CHEMISTRY — Separation Processes and Procedures.**

**32658** (KFK-314) EIN RECHENSCHIEBER ZUR BERECHNUNG DER SPEZIFISCHEN AKTIVITAT BEI NEUTRON-ENAKTIVIERUNG. (A Slide Rule for Calculation of the Specific Activity in Neutron Activation). Schubert, Rolf; Thielen, Cesar (Kernforschungszentrum, Karlsruhe (West Germany)). Mar. 1965. 8p. Dep.(mn).

A slide rule permitting easy calculation of the specific activity without giving intermediate results or requiring additional calculation to determine the correct index of the numbers obtained is described. The slide rule has eight scales. An example of its use is given. (J.S.R.)

**32659** ENRICHMENT OF HEAVY OXYGEN IN WATER BY FRACTIONAL DISTILLATION. Kobayashi, Yasushi; Asano, Takeyoshi. Ann. Rept. Radiation Center Osaka Prefect., 5: 88-9(Mar. 1965).

In order to obtain a sufficient amount of heavy water containing $^{18}O$ for tracer studies, a fractionating column

with Dixon packings was constructed. The column produced 500 ml of 1.3% $H_2{}^{18}O$ in 50 days. The value of HETP was calculated to be 0.75 cm, based on an equilibrium constant of 1.6%. (auth)

**32660** THE POSSIBILITIES FOR PREPARING RADIOISOTOPES IN THE CZECHOSLOVAK CYCLOTRON FOR USE IN METALLURGY AND RELATED FIELDS. Svoboda, K.; Mudrova, B. Hutnicke Listy, 18: 580-3(Aug. 1963). (In Czech)

Radioactive $^{52}Mn$ was produced by bombarding Cr in the cyclotron with $^{2}H$ according to the reaction, $^{52}Cr(d,2n)^{52}Mn$. A large number of isotopes are produced by this reaction; however, the problem is the chemical separation of the carrier-free $^{52}Mn$ (containing a little $^{54}Mn$) from nonactive Cr, $^{48}V$, and $^{51}Cr$. After processing, the carrier-free preparation has a minimum activity of 1 mC/$10^{-7}$ g Mn. A routine process of purification was not worked out, but this isotope was delivered to a few research institutes in mC quantities. $^{52}Mn$ was used to study the transfer of Mn from the coating of electrodes into the weld (filler) metal during electric welding. The half life of $^{52}Mn$ (6 days) makes this isotope convenient to use in foundry research. (OID)

**32661** THE ENRICHMENT OF LITHIUM ISOTOPES BY ION EXCHANGE CHROMATOGRAPHY. THE INFLUENCE OF ELUENT CONCENTRATION ON THE SEPARATION FACTOR. Lee, D. A.; Drury, J. S. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 1405-7 (June 1965). (ORNL-P-375)

The influence of eluent concentration on the separation factor for lithium isotopes was examined. With Dowex-50 and Zeo-Karb resins the separation factors decreased with increasing eluent concentration. Comparable results were obtained using either chloride or acetate eluents. The results were consistent with the ion exchange selectivity theory for the elements. (auth)

**32662** EXPERIMENTAL DETERMINATION OF CLUSIUS-DICKEL COLUMN CONSTANTS FOR BINARY AND POLYNARY ISOTOPE MIXTURES. Mueller, G. (Institut fuer Stabile Isotope, Leipzig). Kernenergie, 8: 226-36(Apr. 1965). (In German)

Some methods are described and proved suitable for experimental determination of the transport equation constants H, $H_0$, K using data of stationary or non-stationary states in thermal diffusion columns. The equations valid for binary mixtures are compared to those for polynary mixtures which also permit the setting time of thermal diffusion column systems and the possibilities of continuous enrichment of medium components of polynary isotope mixtures to be predicted. The results may be applied to all counter-current isotope separation processes. According to this, the general transport equation is formulated. (auth)

**32663** LITHIUM ISOTOPE SEPARATION ON COMPLEX FORMATION. II. KINETIC STUDY OF THE EXCHANGE REACTION OF LITHIUM CHLORIDE–1,4-DIOXANE COMPLEX. Yamashita, Shigeru; Ueda, Mitsutoshi (Osaka City Univ.). Shitsuryo Bunseki, 12: 211-16(Mar. 1965).

The rate of exchange of lithium isotopes $^{7}Li$ and $^{6}Li$ between lithium chloride and lithium chloride–1,4-dioxane complex was studied in 1,4-dioxane solution at 100°C. The rate constant was calculated from the time dependence of the isotope abundance $^{7}Li/^{6}Li$ in the complex with the other information obtained in preliminary experiments. The apparatus used for the determination of $^{7}Li/^{6}Li$ was a sector type mass spectrometer with a surface ionization ion source of the triple-filament type. The value of the second order reaction rate constant was found to be $(1.99 \pm 0.13) \times 10^{-2}$ l mole$^{-1}$, which is comparable with the rate constants of other similar exchange reactions of metal complexes. (auth)

**32664** THE DEPENDENCE OF HYDROGEN ISOTOPE SINGLE SEPARATION COEFFICIENT ON THE CATION COMPOSITION OF A AND X TYPE ZEOLITES. Tolmachev, A. M.; Zotov, T. V.; Eliseeva, N. M. (Moscow State Univ.). Zh. Fiz. Khim., 39: 1021-5(Apr. 1965). (In Russian)

The dependence on the separation coefficients, $\alpha$, for $H_2$, and $D_2$ ($\alpha_{D_2}^{H_2}$), $H_2$ and HD ($\alpha_{HD}^{H_2}$), and HD and $D_2$ ($\alpha_{D_2}^{HD}$) on the cation composition of zeolites of the A and X types was investigated. The value of $\alpha$ decreased with increasing dimensions of the cation. Structural limitations noticeably affected the size of $\alpha$ when the dimensions of the pores were close to the dimensions of the adsorbing isotopic molecule. (tr-auth)

**32665** METHOD OF CONCENTRATING DEUTERIUM IN NATURAL WATER. Schonemann, Karl; Connemann, Joosten. British Patent 979,320. Jan. 1, 1965. Filed May 28, 1962.

A method provides for the concentration of deuterium in natural water using two towers operated at two different temperatures a "hot" and a "cold" tower. The exchange takes place between liquid water and relatively large quantities of gaseous $H_2S$ under pressure. In the "cold" tower water descends countercurrently to cooled and deuterium-enriched $H_2S$. A portion of the deuterium-enriched $H_2O$ produced flows via a heat exchanger to the conventional second "hot" tower. Deuterium-impoverished reheated and humidified $H_2S$ from the cold tower is passed upward through the "hot" tower where it is enriched and then cooled and dried by contact with an ancillary cooling water circuit before re-entry into the "cold" tower. A quantity of the deuterium-enriched water from the "cold" tower that is to be passed to the "hot" tower is passed into the ancillary cooling circuit water stream where it assists in the cooling of the deuterium-enriched $H_2S$. An equal quantity is removed from the cooling-circuit water stream that was heated by contact with the $H_2S$ and led through the heat exchanger en route to the "hot" tower. (B.L.M.)

**32666** METHOD OF MAKING ENRICHED RADIOISOTOPES BY CATION FIXATION. Feng, Paul Y. (to ITT Research Inst.). U. S. Patent 3,167,479. Jan. 26, 1965. Filed Nov. 5, 1963.

A method is described for fast and convenient preparation of enriched radioisotopes including a cation fixation process that is particularly applicable to the preparation of $^{60}Co$, $^{139}Ba$, $^{125}Sb$, $^{124}Sn$, $^{58}Co$, and $^{48}Sc$. The cation to be made radioactive is introduced into an inorganic cation exchange material that is resistant to neutrons and other ionizing radiation. An aluminum silicate clay is such a material and is characterized by a closed lattice structure. The cation is fixed in the exchanger by heating to 700°C for at least 24 hr. Any non-fixed cations are removed prior to irradiation. After irradiation, the radioisotope is defixed and separated from the ion exchanger material. (B.L.M.)

# MATHEMATICS AND COMPUTERS

*Refer also to abstracts 32048 and 32970.*

**32667** (EUR-2298.e) COMPUTER CONTROLLED PHOTOCOMPOSITION. Barnett, M. P. (Massachusetts Inst. of Tech., Cambridge). Mar. 1965. 39p. (CONF-630503-1). Dep.(mn).

From Symposium on Punched Taped Techniques in Documentation, Ispra, Italy.

An account is given of some work that involves the production of paper tapes, by an IBM 709 computer, to control the operation of a Photon S-560 photocomposing unit. In some cases the computer produces these Photon tapes from input tapes which have been prepared on a Flexowriter. In other cases the computer input is prepared on punched cards. The format of the output is described by the user in mnemonic code. The Photon machine can be regarded as a typographic quality output device for conventional computer results in some applications. In other applications the computer performs tedious clerical work in an automated production of catalogues, indexes, and other similar types of publication. (auth)

**32668** (JINR-P-2132) O NEKOTORYKH SLUCHAYAKH SOKHRANENIYA USLOVNOPERIODICHESKIKH DVIZHENII PRI MULOM IZMENENII FUNKTSII GAMIL'TONA. (On Some Cases of Conservation of Conditionally Periodic Motions by a Small Change of the Hamiltonian Function). Mel'nikov, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 8p. Dep.(mn).

A theorem of conservation of conditionally periodic motions by a small change of the hamiltonian function is proved for some new cases. This theorem includes, as a particular case, the Kolmogorov theorem about the conservation of conditionally periodic motions by a small change of the hamiltonian function. (auth)

**32669** (UCRL-11833(p.154-7)) A GENERAL COMPUTER METHOD FOR STATISTICAL ANALYSIS OF DATA. Ewing, Alicia (Lawrence Radiation Lab., Univ. of California, Berkeley).

A flexible program for the statistical analysis of experimental data was described. It is anticipated that such a program is, without modification, useful for computing standard statistical parameters and tests for a wide variety of application. (auth)

**32670** (UCRL-12489) PROGRAM OPTIMIZING TECHNIQUES FOR THE CDC 6600 CENTRAL PROCESSOR. Nelson, Harry L. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 6, 1965. Contract W-6405-eng-48. 57p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

General information is given on the CDC 6600 central processor, after which rules for and examples of optimum coding for the CDC 6600 are presented. The technique of timing analysis is introduced and demonstrated, and the problem of optimization of the inner loop is considered. (T.F.H.)

**32671** STATISTICAL BEHAVIOUR OF CONTENT ADDRESSABLE MEMORIES IN NUCLEAR PHYSICS EXPERIMENTS. De Lotto, I. (CNR-CISE, Milan); Dotti, D. Energia Nucl. (Milan), 12: 310-18(June 1965).

In multiparameter nuclear physics experiments, content-addressable memories are required for an economically feasible multichannel digital analyzer. These memories allow a comparison to be made between each input event and the store content to find the appropriate channel location. As the stored events are selected with reference to their input mean frequency, an interesting problem arises about the statistical distribution of these events. A general survey of the characteristics of these memories is presented. The statistical behavior of this kind of memories is then analyzed, and experimental results are discussed and compared to the theoretical inspections. (auth)

**32672** CONFIDENCE LIMITS FOR MONTE CARLO CALCULATIONS. Burrows, G. L.; MacMillan, D. B. (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 22: 384-5(July 1965). (TID-21147)

A test for departure from normality is outlined for confidence limits based on the results of Monte Carlo calculations. (D.C.W.)

**32673** IRREDUCIBLE REPRESENTATIONS OF THE SPACE GROUPS. Kovalev, O. V. Translated from the Russian by A. Murray Gross. New York, Gordon and Breach Science Publishers, 1965. 156p.

Irreducible one- and two-valued representations of all 230 space groups are presented, and methods for constructing them are briefly discussed. A simple method is given for computing two-valued representations by means of tabulated matrices for so-called loaded representations. Representations of space groups are used in the physics of crystals for solution of problems in which microscopic symmetry is assumed. (L.B.S.)

# METALS, CERAMICS, AND OTHER MATERIALS

## General

*Refer also to abstracts 32048, 32655, 32656, and 33628.*

**32674** (AD-610003) SOME THEORETICAL AND PRACTICAL CONSIDERATIONS IN VACUUM INDUCTION MELTING OF URANIUM ALLOYS. Schaffer, Philip S. (Watertown Arsenal Labs., Mass.). 1961. 18p. (WAL-MS-33). $1.00(CFSTI).

Procedures of melting, refining and casting of depleted uranium alloys were developed utilizing vacuum induction melting techniques, a hand-rammed commercially pure magnesia crucible and a phosphate-bonded zircon sand mold. It is believed that this combination yields a melting and casting procedure that results in a reduction of residual gas content; secondly, minimizes crucible-melt reactions; and thirdly, avoids possible metal-mold reactions. Optimum results with this procedure are obtained by pouring the molten uranium under dynamic vacuum conditions to obtain a stream degassing effect and then introducing a positive pressure of inert gas immediately upon filling the mold, in order to prevent nucleation and possible evolution of gas during solidification. The overall processing procedure results in a reduction of residual gas concentration in the uranium alloy and produces castings with ductile qualities in the as-cast condition. (auth)

**32675** (BM-RI-6636) STAINLESS STEEL–GADOLINIUM ALLOYS. Copeland, M.; Barstow, W.; Armantrout, C.; Kato, H. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Sept. 1964. Contract AT(11-1)-599. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Phase relations of gadolinium alloyed, up to 40 wt pct, with AISI 304-type stainless steel was established. Body- and face-centered cubic iron-rich solid solution phases and several intermetallic gadolinium-containing compounds of variable composition that approximated the formulas $Fe_9Gd$, $Ni_7Gd_2$, $Ni_3Gd$, $Fe_2Gd$, NiGd, and $NiGd_3$ were identified. The intermetallic phases $Fe_9Gd$ and $Ni_7Gd_2$ were noted to melt at about 1,080°C at about 0 to 2 wt pct gadolinium. The melting temperature of $Fe_9Gd$ increased with increasing gadolinium content to a plateau at about 1,230°C and 30 wt pct gadolinium and the melting point of $Ni_7Gd_2$ decreased to a plateau at 900°C and 30 wt pct gadolinium where $Ni_3Gd$, NiGd, and $Fe_2Gd$ coexist. Body-centered cubic iron solid solution was stable from 1 to 2 wt pct gadolinium to higher contents, 30 wt pct gadolinium or possibly more, and face-centered cubic iron up to 12 wt pct gadolinium below 1,200°C. The stability of these phases above 1,200°C was not resolved except for the melting points. A limited number of fabrication variables as well as mechanical and corrosion properties of alloys containing up to 5 wt pct gadolinium were studied. Equilibrating and forming operations were best conducted at about 940 to 1,080°C. Some variability in the yield and tensile strengths of alloys was noted; however, there was a continual decrease in ductility and impact resistance with increasing gadolinium contents. The resistance of gadolinium alloys to corrosion in water at 354°C was about the same as stainless steel. (auth)

**32676** (BMI-1717(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING FEBRUARY 1965. Dayton, Russel W.; Paprocki, Stan J. (Battelle Memorial Inst., Columbus, Ohio). Mar. 1, 1965. Contract W-7405-eng-92. 44p. Dep.; $1.00(cy), 1(mn) CFSTI.

Progress is reported on development of reactor materials and components, reactor fuels development, radioisotope and radiation applications, coated-particle fuel materials development, and support work for the Army ML-1 program. (W.L.G.)

**32677** (BNWL-67) SOLID-STATE ELECTRODIFFUSION IN BISMUTH. Moore, R. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Experiments on electrodiffusion of various materials in bismuth were made in an attempt to develop a technique for rapidly separating bismuth. It was found that a 5 in. long by $\frac{3}{8}$ in. dia bismuth bar clamped between $\frac{3}{4}$ in. dia aluminum electrodes will melt near its center upon passage of a current slightly in excess of 85 amp/cm$^2$. When a specimen is immersed in a nonvolatile hydrocarbon oil circulated over cooling coils situated near the specimen, successful electrodiffusion runs of up to 330 hr were achieved at current densities of 260 amp/cm$^2$. This represents a power density increase of about an order of magnitude. Despite attainment of practical current densities over prolonged periods, no electrodiffusion of $^{210}Po$, of a tellurium "stand-in," or of trace impurities in bismuth was observed. Heated by a d-c current, the specimens exhibited a temperature gradient of from 120 to 140°C from the center to the ends. This thermal gradient produced slight diffusion (Soret effect) of $^{210}Po$ from the hot center toward the cold ends. Diffusion rates were, therefore, not limiting. $^{210}Po$ was simply not affected by the passage of the electric current. This implies that the effective valence of bismuth and of $^{210}Po$ is the same and the electric field will not accelerate $^{210}Po$ with respect to the bismuth lattice. Additionally, the cross-section for electron momentum transfer effects must be quite similar for both bismuth and $^{210}Po$, or extremely small. (auth)

**32678** (GEMP-48A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 48, PART A. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 25, 1965. Contract AT(40-1)-2847. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Krypton was concurrently dissolved and diffused in Ta cathode samples which were self-resistively heated to 1730°C while under glow discharge for different exposure times and pressures. These diffusion samples were sectioned in 400 Å-thick sections. The data obtained suggested that a constant surface concentration is maintained during the experiments (up to 10 minutes). Analysis of the data indicated that diffusion along high diffusivity paths was the dominant transport process beyond about 400 Å. Post-irradiation analysis of the in-pile ducting used with fueled BeO tests at temperatures up to 1550°C confirmed previous indications that the dominant fission product release process is recoil. Chemical analysis of $UO_2-ThO_2$ and $UO_2-ThO_2-Y_2O_3$ fueled-BeO specimens from fuel retention tests at high temperatures in various atmospheres confirmed the excellent stability of the $Y_2O_3$-containing compositions. Measurement procedures for determining bulk volume and density and open and total porosity of ceramic specimens to a precision of ±0.1% are described. The procedure utilizes vacuum impregnation with toluene and diethylphthalate fluids rather than water. Density and porosity measurements of unirradiated BeO specimens representative of the compositions, grain sizes, and densities used in the irradiation studies showed that the open porosity exceeded 1% only if the total porosity was greater than 10 to 12%. Post-irradiation measurements on additional specimens containing glass-phase additives provided further evidence that these additives lead to slightly increased expansion at irradiation temperatures of 900 to 1000°C. Electron micrographs of polished sections of the 20-μ grain size AOX-grade and EBOR composition samples irradiated at 1000°C to 2.5 to $3 \times 10^{21}$ nvt (≥1 Mev) failed to yield evidence of microcracking. Additional examinations are in progress; however, it appears now that these are the first irradiated specimens to exhibit a decrease

of 20 to 40% in strength in the absence of microcracking. (W.L.G.)

**32679** (IDO-17037) ANNUAL PROGRESS REPORT ON REACTOR FUELS AND MATERIALS DEVELOPMENT FOR FY 1964. Graber, M. J.; Zelezny, W. F.; Gibson, G. W. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1964. Contract AT(10-1)-205. 53p. Dep.; $3.00(cy), 1(mn) CFSTI.

Development work on $UAl_3$, $UAl_4$, $U_3Si$, UC, UN, $UO_2$, and $U_3O_8$ for fuel elements is reported. Electron microprobe analyses on aluminum dispersion type fuel plates were used to evaluate the effects of temperature on the stability of particulate uranium compounds. The changes in properties, stability with irradiation, and the effects of modifying fuel plate fabrication procedures were determined. Prototypes of new MTR or ETR type fuel elements containing uranium-bearing Fiberglas, $U_3O_8$, or $UAl_3$ were procured. Aluminum–beryllium alloys were evaluated and beryllium capsule experiments are underway. Aluminum–uranium intermetallic dispersions in aluminum are in a more concentrated form after irradiation than the uranium oxides. Foils containing $B_4C$ can be used as a means of dispersing burnable poisons in fuel elements. Radiation does not interfere with the strengthening mechanism of APM's (Alcoa Powder Metallurgy Alloys) containing $Al_2O_3$ dispersions. The corrosion resistance of 50 weight percent aluminum–beryllium alloy is microstructurally dependent. (auth)

**32680** (IDO-17052) NUCLEAR TECHNOLOGY BRANCHES QUARTERLY REPORT, JULY 1–SEPTEMBER 30, 1964. Formerly—Materials Testing Reactor-Engineering Test Reactor Technical Branches. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1965. Contract AT(10-1)-205. 94p. Dep.; $3.00 (cy), 2(mn) CFSTI.

The Advanced Test Reactor Critical Facility (ATRC) is back in operation after being shut down to replace the temporary neck-shim housing used during the initial start-up with a permanent housing identical to the one for the ATR. With only a few exceptions, the ATRC is now a full-scale nuclear duplicate of the nuclear portion of the ATR. One difference is in the neck shims. The ATRC is presently using neck shims from the ATR Critical Experiment. These shims have a reactivity worth of 113% of those for the ATR. Reactivity measurements were also made in the ATRC which show that the range in natural B content in the ATRC fuel elements is −0.3 g and +0.2 g from the 4.0 g specified. Measurements of gamma dose rates and neutron flux levels in instrument thimbles that rise vertically above the core have been measured in the Engineering Test Reactor Critical Facility (ETRC.). The results of these measurements provide a check on calculational techniques used for comparable ATR parameters. The branching ratio for the 59.6-keV gamma transition following the decay of $^{241}Am$ was measured. Studies of the decay of long-lived $^{166}Ho$ were completed and reported. Initial studies of the decay of 9.3-hr $^{156}Sm$ are reported. Much additional work is contemplated on this nuclide. A tabulation of factors needed to determine the number of radioactive nuclei in a given sample is given for a large number of common radionuclides in reactor oriented laboratories. A proving ring was developed to measure the radial expansion of fuel elements. The ring fits around the fuel elements and measures expansion by means of four strain gages attached to the ring. It was successfully employed on PBF fuel element measurements. Several hypothetical cases of fluid flow transients resulting from ruptures in reactor primary coolant systems were analyzed on the analog computer. The mathematical models developed yielded realistic results of pressure and flow in various locations in the system. A development project resulted in a gain stability analyzer capable of determining gain changes of ±0.002% for long and short term stability determinations. The initial version of Phillips' general purpose Monte Carlo program is near completion, and a description of the important features of the code is included. A summary of IDO-16983, Some Methods of Calculation of the Parameters in the Reactor Kinetics Equations, is included. A program was written to allow IREKIN (a numerical solution of the reactor kinetics equation) and HEAT 1 (a one-dimensional time dependent or steady-state heat conduction code) programs to be run together or as a single job. Several programs were written for gamma ray spectral analysis. Also included is a program for Vacation Eligibility. (auth)

**32681** (MAB-199-M(3)) THIRD PROGRESS REPORT BY THE COMMITTEE ON BERYLLIUM METALLURGY OF THE MATERIALS ADVISORY BOARD. (Materials Advisory Board, National Academy of Sciences–National Research Council, Washington, D. C.). June 1, 1965. 44p.

The purification processes for Be are reviewed and summaries of sponsored Be research contracted since June 1964 are given. (W.L.G.)

**32682** (MSAR-65-89) STRAIN-ENHANCED DIFFUSION OF CARBON IN STAINLESS STEEL. Literature Survey. Hiltz, R.; Tepper, F. (MSA Research Corp., Callery, Pa.). June 29, 1965. Contract AT(11-1)-765. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A literature survey was conducted on the effect of strain on diffusion of alloy or impurity elements in a metal matrix. An explanation for the observed effect of strain-enhanced carburization of stainless steel is proposed. (W.L.G.)

**32683** (NMI-1262) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. DEVELOPMENT OF URANIUM-BASE ALLOYS STRENGTHENED BY SLIS TECHNIQUES. Summary Technical Report to the United States Atomic Energy Commission for the Period July 1, 1963–June 30, 1964. Kaufmann, A. R.; Muller, W. C. (Nuclear Metals., West Concord, Mass.). Dec. 2, 1964. Contract AT(30-1)-2784. 83p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A program was carried out to develop new improved uranium-base alloys by the SLIS technique in which dispersions are achieved with metallic particles rather than oxides. The alloying elements are those which are highly insoluble in the solid state and, thus, have little tendency to agglomerate at elevated temperatures. U–Be, U–C, U–Be–C, and U–Al–Si alloys were prepared by dissolving the alloying elements in liquid U and then quenching rapidly by splatcooling. Examination of the as-quenched U–Al–Si alloy at magnifications up to 30,000× failed to show any precipitate particles. However, a similar examination of the U–Be, U–Be–C, and U–C alloys revealed that precipitates about 0.008 $\mu$ dia were achieved. Following compaction at 600°C plus extrusion at 500°C a precipitate was observed in the U–Al–Si alloy; the precipitate was of irregular shape, being about 0.1 to 0.4 $\mu$ across. Particle concentrations in the range of from $1 \times 10^{12}$ to $5 \times 10^{12}$ particles per $cm^3$ were observed in the splatcooled alloys following compaction and extrusion. Aging of the splatcooled U–Al–Si alloy for 100 hours at 600°C showed considerable particle agglomeration. Similar aging of the U–Be and U–Be–C alloys showed only a moderate growth in particle size. After aging of these alloys an increase in particle size was usually accompanied by a decrease in particle concentration. The results indicate that the strength of splatcooled U can be increased substantially at 600°C with additions of up to 0.4 wt % Be metal. (auth)

**32684** (NMI-8001.2) STUDY OF METHODS TO CONTROL GRAIN SIZE, PURITY, AND TEXTURE IN BERYLLIUM AND BERYLLIUM ALLOYS. Bi-Monthly Letter Report, December 1964–January 1965. Muller, W. C.; Wolff, A. K. (Nuclear Metals, West Concord, Mass.). Feb. 12, 1965. Contract NOw-65-0084-f. 7p.

The process steps used to produce attritioned splatcooled SSR-grade Be metal and Be-base alloys are described. The process is first being checked out with relatively low-cost CR flake Be. (W.L.G.)

**32685** (UCRL-14128) THE PURIFICATION OF PLUTONIUM BY ELECTROLYSIS OF THE SOLID METAL. Wade, W. Z.; Wolf, T. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 15, 1965. Contract W-7405-eng-48. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A series of experiments was conducted to determine the transport of impurities within the plutonium lattice under the impress of d-c voltage with heavy current flow. Each rod (1/4 in. diameter × 4 in. long) of alpha plutonium metal was raised to 500°C in a vacuum, 100 d-c amperes sent through it, and these conditions maintained for periods of 100, 200, 500, and 1000 hr. Although complete spectrographic analyses were made for all metallic impurities, primary attention was placed on the migration of iron. Iron constitutes one of the major impurities in alpha plutonium and its concentration along the test bars at the completion of these runs was quite markedly affected. At 1000 hr, with a starting concentration of 336 ppm Fe in the original material, 35% of the bar nearest the cathode had 60 ppm, while the extreme anode end had in excess of 820 ppm Fe. Rods run at smaller time periods also had marked concentration gradients, but not quite as extreme. (auth)

**32686** (NP-tr-1236(p.35-40)) ELECTROLYTIC PLATING OF BERYLLIUM ONTO COPPER FROM FUSED SALTS. Anfinogenov, A. I.; Smirnov, M. V.; Ilyushchenko, N. G.

A study was made of the polarization of a copper cathode during the deposition on it of beryllium from molten salt electrolytes at various temperatures and current densities. It was established that the composition of the potential-determining surface layer of the cathode depends on the ratio of the rates of beryllium deposition (i.e., the current density) and beryllium diffusion into the deep layers of the electrode (i.e., the temperature). It was shown that the cathode deposition of beryllium on copper preferentially forms the $\beta$-phase in the surface layer of the cathode. Other phases may be accumulated only at definite current densities and temperatures. Thus, the $\alpha$-phase, which is of greater practical interest, is formed at temperatures of 700–800° only when the current density does not exceed 0.002 amp/cm$^2$. (auth)

**32687** IMPROVEMENTS IN OR RELATING TO HEAVY METAL CARBIDES. Bel, Alain; Pascard, Roger (to Commissariat a l'Energie Atomique). British Patent 993,717. June 2, 1965. Priority date June 19, 1961, France.

A process for producing sintered carbides of the actinides comprises mixing the powdered carbides with 0.2 – 1 wt % of powdered Fe, Co, or Ni and with an organic binder, naphthalene or paraffin, cold pressing the mixture at a low temperature at a pressure of 3 – 5 metric T/cm$^2$, and sintering in a vacuum for up to 4 hr at 1400 – 1550°C. The sintered carbide is cooled at a rate of 200° C/hr. The particles of the carbide and metal powder in the starting mixture have a size range passing a 35$\mu$ screen. Sintered articles produced by the process have a density in excess of 92% of the theoretical density. (B.L.M.)

**32688** METHODS OF MANUFACTURING FISSIONABLE MATERIALS FOR USE IN NUCLEAR REACTORS. Englander, Marcel; Stohr, Jacques Andre (to Commissariat a l'Energie Atomique, Paris). U. S. Patent 3,177,069. Apr. 6, 1965. Priority date June 14, 1955, France.

An alloy of U with 0.1–2+ wt % Al and 0.05–1 wt % Zr is melted under vacuum, held at 1500°C until dissolution and degassing are complete, poured into molds, and allowed to solidify. The molded alloy is heated under a vacuum of $10^{-3}$ mm Hg at a temperature higher than 1000°C but lower than the melting point of the alloy for about 50 hr, then suddenly quenched and annealed at about 600°C for about 10 min. (A.G.W.)

**32689** METHODS FOR MAKING URANIUM CARBIDE ARTICLES. Accary, Andre; Dubuisson, Jacques (to Commissariat á l'Energie Atomique). U. S. Patent 3,173,753. Mar. 16, 1965. Priority date Nov. 6, 1959, France.

Uranium carbide articles of specific gravity as high as 50–60% of theoretical specific gravity are produced without mechanical pressure. Uranium and graphite powders are mixed in substantially stoichiometric proportions, poured into a mold, and vibrated to increase the specific gravity of the mixture. The mold is then placed under vacuum and heated gradually to about 1200°C. After the mold is cooled, the article is easily removed. (A.G.W.)

**32690** FUSED ALUMINA–ZIRCONIA ABRASIVES. Marshall, Douglas W.; Roschuk, Steven J. (to Norton Co.). U. S. Patent 3,181,939. May 4, 1965. Filed Jan. 27, 1961.

A high impact strength abrasive that is suitable for snagging stainless steel is described. A fused eutectic of high purity alpha–alumina and zirconia is prepared by fusing 15–30 wt % of zirconia and the balance alumina in an arc tapping furnace and pouring the fused product into a cast iron ingot mold for rapid quenching. The cooled cast product is crushed into grit. The abrasive material contains a mixture of the eutectic and crystals of either alpha–alumina or zirconia of an average size not greater than 300$\mu$. (B.L.M.)

**32691** URANIUM MONOSULFIDE-MONOCARBIDE NUCLEAR FUEL ELEMENT. Handwerk, Joseph H.; White, George D.; Shalek, Patrick D. (to U. S. Atomic Energy Commission). U. S. Patent 3,194,745. July 13, 1965.

A mixture of uranium monosulfide and uranium monocarbide for use as a reactor fuel is described. (AEC)

## Corrosion

*Refer also to abstract 32657.*

**32692** (AD-426040) HIGH-TEMPERATURE OXIDATION PROTECTIVE COATINGS FOR VANADIUM-BASE ALLOYS. Bimonthly Report, October 1–November 30, 1963. (IIT Research Inst., Chicago, Ill.). Jan. 2, 1964. Contract NOw-64-0140-c. 11p. (IITRI-B6019-1). $1.60(CFSTI).

Primary experimental effort was on determining the influence of the coating process on the ductile-to-brittle transition behavior of coated V–60Nb–1Ti sheet. Eleven tensile samples of V–60Nb–1Ti sheet were coated in two separate pack runs under similar conditions. Several of these were tested at 32, 140°F and room temperature in the as-coated condition. In addition, specimens were vacuum annealed and oxidized after coating and subsequently tested at room temperature. For specimens tested in the as-coated condition, brittle failure occurred at both 32°F and room temperature. At 140°F the material was ductile, having tensile properties similar to the uncoated, annealed alloy at room temperature. It appears, therefore, that a brittle-to-ductile transition occurs at just above room temperature. (auth)

**32693** (AECL-2257) AECL EXPERIMENTS ON THE CORROSION OF ZIRCONIUM ALLOYS UNDER IRRADIATION. Cox, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1965. 73p. Dep.; $1.50(AECL).

The corrosion of zirconium alloys under irradiation was examined by exposing corrosion specimens in the water-cooled loops. The results of these experiments are reported and compared with evidence obtained from the examination of fuel cladding in the same experiments where this is available. The data on Zircaloy-2, the alloy for which most information is available, are compared with the results of experiments elsewhere, and it is concluded that the observations of oxidation and hydrogen absorption are influenced considerably by conditions in the specimen's environment. Thus, oxidizing conditions in the loop coolant have often been accompanied by increasing weight gains and reduced hydrogen uptake. Under reducing conditions the observed oxide film thickness is normal. (auth)

**32694** (CNLM-6028) INVESTIGATION OF CAVITATION DAMAGE OF A MECHANICAL PUMP IMPELLER IN HIGH-TEMPERATURE POTASSIUM. Quarterly Progress Report No. 1, December 7, 1964–February 28, 1965. R. S. Kulp and J. V. Altieri (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Apr. 1965. Contract NAS-3-6468. 83p. (NASA-CR-54383). CFSTI.

A three-vaned mixed flow centrifugal impeller was water-tested with an acrylic lacquer coating to determine the effects of vane tip clearance on the degree of cavitation damage which may be expected in endurance tests in 1400°F–K. A range of net positive suction head (NPSH) values was investigated at five vane tip clearance settings. The time required to remove the lacquer coating and size of the area removed will be used to select an NPSH condition for the K test. (auth)

**32695** (CONF-650518-1) DAMAGE TO SOLIDS CAUSED BY CAVITATION. Hammitt, Frederick G. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). 1965. 44p.

From Royal Society Discussion on Deformation of Solids Due to Liquid Impact, London.

A survey is presented of the present state of research aimed toward predicting cumulative damage for a given prototype flow situation from laboratory experiments. Some of the more significant facts and hypotheses are described. The various factors involved are considered: sample orientation, fluid purity, velocity, etc. (D.L.C.)

**32696** (EURAEC-783) QUARTERLY REPORT NO. 5 [ON CORROSION TESTING], APRIL 1, 1963–JUNE 30, 1963. (Compagnie Pechiney, Chambery (France)). July 31, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 067-62-4 RDF. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Ternary and quaternary alloys were prepared by adding Al, Sn, and Ti to Zr–Ni or Zr–V alloys. Corrosion tests were performed in steam at 400°C for 340 hrs. The quaternary alloys and the alloys containing Al experienced severe corrosion. The Ni–Sn–Zr and Sn–V–Zr alloys exhibited corrosion resistance. Heterogeneous ingots were obtained when adding large amounts of Sn to Zr–base alloys due to the segregation of Sn during casting. (W.L.G.)

**32697** REACTION OF MOLTEN Al AND OF Al-20 WT. % U WITH WATER VAPOUR. Robertson, A.; Rostron, A. J. (Arthur D. Little Research Inst., Musselburgh, Scot.). Corrosion Sci., 5: 425-47(June 1965).

The oxidation of Al in water vapor or Ar–water-vapor mixtures at 800 to 1400°C and Al–20 wt % U alloy in water vapor at 930 to 1400°C was investigated. The samples were heated and suspended in the vapor stream by electromagnetic levitation and the concentration of reaction product $H_2$ recorded continually. Provided the oxide layer did not break down, the oxidation rate was parabolic for a short interval after reaching a constant temperature. The rate then decreased rapidly until, depending upon the temperature and vapor pressure, it became approximately constant or exhibited pulsed behavior. If the temperature exceeded 1050°C in pure Ar or 1700°C in 100% water vapor, the oxide layer broke down and the rate remained at a high value. The results are discussed in terms of $H_2$ dissolving into the metal, formation of amorphous and then crystalline oxide, oxide cracking, suboxide formation, and oxide disruption by $H_2$ pockets. (W.L.G.)

**32698** ON THE AQUEOUS CORROSION OF SOME ZIRCONIUM–TITANIUM ALLOYS. Leach, J. S. Llewelyn; Nehru, A. Y. (Imperial Coll. of Science and Tech., London). Corrosion Sci., 5: 449-53(June 1965).

The rate of oxide growth on three Zr–Ti alloys in a 0.1N KOH solution at 90°C was measured as a function of time and applied potential. The corrosion rates of the 3 alloys were increased by increasing the cathodic polarization and were greater than that of pure Zr. However, the Zr–0.5 Ti alloy corroded more rapidly than the Zr–1.0 Ti alloy. This anomalous behavior could not be explained. The 0.5 wt % Ti and 1.0 wt % Ti alloys show transitions from protective to nonprotective kinetics at the lower potentials. The transition from nonprotective to protective kinetics of the Zr–3.0 Ti alloy is associated with preferential oxidation of one of the constituents. (W.L.G.)

**32699** ON THE FORMATION OF HYDRIDES WITH ANODIC SOLUTIONS OF TANTALUM IN METHANOL. Schmidt, E.; Bieri, H.; Huber, K. (Universitat, Bern). Corrosion Sci., 5: 455-7(June 1965). (In German)

Tantalum is anodically activated in water-free halide-containing methanol and forms tantalum hydrides. The mechanism of hydridation was studied using deuterium and mass spectrometric techniques. (M.C.G.)

**32700** PROTECTION OF MOLYBDENUM AND TUNGSTEN AGAINST HIGH-TEMPERATURE CORROSION BY GALVANIC COATINGS. Kvokova, I. M.; Layner, V. I. Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met., No. 5, 129-34(1964). (In Russian)

Preparation of the surface of W and Mo specimens for electrolytic plating by electrolytic etching in NaOH and $H_2SO_4$ electrolytes followed by Cr plating and subsequent Ni plating to increase high-temperature corrosion resistance from 700 to 1100°C is described. Selection of optimum electrolysis temperature and concentrations of $H_2SO_4$ in electrolytes to provide crack-free coatings with high adhesive strength is discussed. (Rev. Metal Lit., 22: No. 3 (Mar. 1965))

**32701** INHIBITION OF THE CORROSION OF METALS BY STEAM AT HIGH TEMPERATURES. Wanklyn, John Nelson; Frederick, Colin (to United Kingdom Atomic Energy Authority). U. S. Patent 3,171,789. Mar. 2, 1965. Priority date Dec. 9, 1960, Great Britain.

The corrosion of metals by dry steam at high temperature and high pressure may be inhibited by introducing boric acid into the steam. Metals for which corrosion is inhibited include Zr, Be, Al, and Zr alloys. When the steam is used as a reactor coolant, the boron should consist essentially of $^{11}B$. (A.G.W.)

## Fabrication

*Refer also to abstract 33353.*

**32702** (AD-609653) RESEARCH DEVELOPMENT AND TEST OF REFRACTORY METAL ALLOY FASTENERS. Shaver, C. J. (Republic Aviation Corp., Farmingdale, N. Y.). July 1964. Contract AF33(616)-8104. 152p. (FDL-TDR-64-113). $5.00(CFSTI).

The problem of producing and using standard fasteners (metallic) for use to 3000°F was investigated. The final production phase consisted of one Mo alloy, TZM, and one Nb alloy, Nb 752, with the threaded fasteners incorporating a special thread form. The Pfaudler PFR-6 coating was used on the Mo alloys while the Tapco Cr–Ti–Si coating was used on the Nb alloys. Final approved fastener configurations for both alloys included: common rivets (brazier head), Hi-shear rivets (flush head), flush head screws, hexagon head bolts, and nuts for use with the threaded fasteners. Blind fasteners were produced from Nb alloys only. Tensile and shear data are presented encompassing the temperature range –320 through 3000°F. Ambient and elevated temperature fatigue and joint test data are also presented. The program has shown that usable fastener configurations can be manufactured from Mo and Nb alloys, and that the resultant items can be successfully coated for satisfactory oxidation protection at nominal utilization temperatures. Extremely large reductions in load carrying capability at ambient temperatures were experienced in the Mo alloys after coating. This phenomenon was not as serious in the Nb alloys. (auth)

**32703** (EURAEC-1297) WELDING OF VERY THICK STEELS. Quarterly Report No. 13, October 1–December 31, 1964. (Soudometal, S. A., Brussels (Belgium)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 042-61-9 RDB. 28p. (EUR-2092). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress is reported on the Robertson tests on the transformation zones and basic steels, the determination of the $A_1$ and $A_3$ transformation temperatures of the filler metals, and Charpy V transition curves on types 37A and 47A basic steels. (W.L.G.)

**32704** (IITRI-B237-34) PROTECTIVE COATINGS FOR REFRACTORY METALS IN ROCKET ENGINES. Summary Report, March 15, 1964–December 15, 1964. Rausch, John J. (IIT Research Inst., Chicago, Ill.). Mar. 24, 1965. Contract NAS7-113. 69p.

This program is directed to developing protective coating systems for tungsten and tantalum alloys for use in low-pressure, liquid-fueled rocket engines. The primary effort has been on the development of composite refractory oxide-tungsten rocket nozzles fabricated on removable mandrels by plasma spraying, and on the use of Hf–Ta alloys as reservoir-type coatings on a Ta–10W substrate. Composite coating systems based on W–$HfO_2$–$SrZrO_3$ were further studied in an attempt to reduce residual fabrication stresses and the stress interaction resulting from thermal expansion mismatch. A nozzle, reinforced to provide additional thermal shock resistance, was fabricated to provide a means of evaluating the coating system. Engine firing test results indicate that under these conditions the composite systems are capable of withstanding the thermal stress generated during initial heating and provide oxidation resistance for the tungsten substrate. The restart capability and durability of the materials have not been determined as yet. The fabrication technology for producing Hf–Ta alloy clad Ta–10W alloy sheet and subsequently spinning this material to rocket nozzle configuration was established. Nozzles produced in this manner withstood an engine firing test for 65 sec at a calculated average wall temperature of 3400°F. Attempts to evaluate the nozzles under more extreme engine operating conditions were complicated due to a severe radial temperature distribution which resulted in the throat area. (auth)

**32705** (TID-21918) LUBRICATION STUDY OF URANIUM SURFACES. PHASE I. Interim Progress Report No. 1. Carloni, Q. C. (Bridgeport Brass Co., Conn.). Feb. 1, 1962. Contract AT(30-1)-1405. 23p. (HAVENS-191) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Elevated temperature tests were conducted on many conventional lubricants and coatings that were applied to different uranium surfaces to determine their behavior in various environmental surroundings. Results obtained indicate that E.S.B. on an as-machined surface sustains a temperature of 700°F when heated in air. Three lubricants, M-88, Dag 41, and X-15 proved their superiority as compared to others when evaluated in oil. Results of in-salt heated samples show Dag 250 and E.S.B. sustain temperatures of 600 and 700°F, respectively, on various surface conditions. (auth)

**32706** (UCRL-14174) RECONDITIONING OF PLASTIC-COATED FUEL ELEMENTS. Freitas, Donald (Lawrence Radiation Lab., Univ. of California, Livermore). May 1965. Contract W-7405-eng-48. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Worn plastic coatings on oralloy foil fuel elements are replaced to extend the useful life of the fuel elements. The process involves removal of the old plastic with acetone in an ultrasonic vibrating tank, cleaning with alcohol, and silk screening the new plastic on the fuel elements. The procedure meets all requirements of safety, accountability, security, precision, and repeatability. (auth)

**32707** (JPRS-29696) JOINT PLASTIC DEFORMATION OF DISSIMILAR BODIES. Arkulis, G. E. Translated from p.1-271 of "Sovmestnaya Plasticheskaya Deformatsiya Raznykh Metallov." Moscow, Metallurgia, 1964. 277p. (TT-65-30793). $6.00(CFSTI).

This book treats the theory of the manufacture of products from multilayer materials. The effect of the number and properties of the components, dimensions, friction coefficients, and compression on stresses, distortion, etc. are studied. An analysis of such production processes as drawing and rolling is also included. (D.L.C.)

**32708** (NP-tr-1233) MANUFACTURE OF MIXED URANIUM AND PLUTONIUM OXIDE PELLETS BY SINTERING. Translated for Atomic Power Development Associates, Inc., Detroit, Mich., from the French. [nd]. 12p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

Dense, mixed $UO_2$–$PuO_2$ pellets in clad 316 L stainless steel tubes are required as the first fuel charge for the RAPSODIE reactor. A process was developed for the production of dimensionally true pellets without the need for machining. Laboratory and process studies are described. (D.L.C.)

**32709** SINTERING OF HIGH PURITY MAGNESIUM OXIDE WITH HAFNIUM DIOXIDE. Budnikov, P. P.; Matveev, M. A.; Yanovskii, V. K. (Mendeleev Inst. of Chemical Engineering, USSR). Ogneupory, No. 4, 32-7 (1965). (In Russian)

By the introduction of hafnium dioxide to very pure active magnesium oxide, its sintering is considerably accelerated and at 0.1 to 0.3 mol % $HfO_2$ ceramics with apparent density of 99 to 100% of the theoretical (3.56 to 3.63 g/cm$^3$) can be obtained after annealing at 1300 to 1400°C. The optimum amount for the addition of $HfO_2$ is 0.25 mol %. The temperature of tempering mixtures of magnesium hydroxide and admixtures, obtained by co-precipitation from $MgCl_2$ and $Hf(SO_4)_2$ ammonia solutions, and the compression pressure slightly affect the final density of the ceramics. The sintering of MgO with 0.25 mol % $HfO_2$ starting at 950°C, after which the apparent density rapidly increases with increasing annealing temperature, approaches 3.40 g/cm$^3$ at 1100°C. Collective recrystallization at this low temperature takes place slowly and sintering is not accompanied by significant grain growth. At 1300°C and higher temperatures, shrinking approaches the maximum after several minutes. Volumetric self-diffusion from grain boundaries to the surface appears by the mechanism of material transfer during sintering. The activation energy of this process [3.9 ev ($6.2 \times 10^{-16}$ joule) in the interval from 1100 to 1300°C] and the calculated coefficient of self-diffusion of MgO agree with the available data on the diffusion of Mg in MgO. (tr-auth)

**32710** METHOD OF MAKING GRAPHITE ARTICLES. Woodburn, James, Jr. (to Griffin Wheel Co.). British Patent 994,146. June 2, 1965. Filed Jan. 4, 1962.

A method is described for making made-to-shape graphite articles such as thermocouple tips, crucibles, and molds for high-production castings. Carbon aggregate composed of a mixture of petroleum coke flour and soot is mixed with a furfuryl resin binder, resins made from either furfuryl alcohol or furfural. An acid catalyst, maleic anhydride, is added to the mixture, and the mixture is shaped into an article. While the article is unsupported laterally, it is cured to set the binder. The article is fired in a substantially $O_2$-free atmosphere at a temperature sufficient to carbonize the binder, and then the article is graphitized. The process produces articles of more uniform porosity, because the binder does not liquefy and migrate during firing, and because the pressure of volatile components does not distort the piece. (B.L.M.)

**32711** METHOD FOR THE PRODUCTION OF SINTERED BODIES OF $U_3Si_2$. Steinkopff, Horst; Huettig, Wilfried (to Deutsche Akademie der Wissenschaften). German Patent 1,191,972. Apr. 29, 1965. Filed Feb. 24, 1962.

Sintered bodies of $U_3Si_2$ are produced at a temperature between 1300 and 1400°C and with a reproducible density of 96 to 98% of the theoretical density of $U_3Si_2$. The source material for the pressing and sintering process is $U_3Si_2$ powder with a metallic component in the form of a small amount (at least 0.15%) of iron, nickel, chromium, cobalt, or manganese. (Gmelin Inst.)

**32712** METHOD OF PRODUCING CIRCULARLY CYLINDRICAL MEMBERS OF MATERIAL COMPOSED ESSENTIALLY OF ZIRCONIUM AND OR NIOBIUM. Takahashi, Shuichiro; Honda, Yutaka; Maekawa, Tasuo; Ikawa, Yukio; Yamamori, Sueo (to Mitsubishi Atomic Power Industries, Inc. and Mitsubishi Denki Kabushiki-Kaisha). U. S. Patent 3,168,399. Feb. 2, 1965. Priority date May 11, 1960, Japan.

Tubes of Zr and/or Nb may be formed by arranging coaxially a pair of metallic tubular members of circular cross section and of different diameters to form an annular space between, filling the space with the desired material in powder form, closing the ends of the space,

subjecting the assembly to a swaging operation at a temperature between room temperature and ~1000°C, and removing the metallic members by mechanical and chemical means. Bars are similarly produced by eliminating the internal tube. Removal of the tubular members is facilitated by lining the surfaces to contact the powder with a thin layer of copper. (A.G.W.)

**32713** PROCESS FOR PRODUCING HIGH DENSITY NUCLEAR FUEL PARTICLES. St. Pierre, Philippe D. S. (to General Electric Co.). U. S. Patent 3,168,479. Feb. 2, 1965. Filed Oct. 28, 1960.

A process is reported for the preparation of high-density (at least 95%) fuel particles of thorium oxide or thorium oxide and uranium oxide. A thermally decomposable compound of thorium alone or in combination with a similar compound of U is formed into a green compact with 0–10 wt % of water under a pressure of ½ to 10 T/in². The compact is decomposed in an atmosphere of wet $H_2$ by heating to a temperature of 700°C. The rate at which the temperature is raised is in inverse proportion to the compacting pressure both for the decomposition heating and sintering. After the material in the compact is decomposed, the temperature is raised to 1500 to 1700°C in the presence of wet $H_2$ to sinter the compact, and the sintered product is cooled in a dry $H_2$ atmosphere. (B.L.M.)

**32714** PROCESS FOR THE PRODUCTION OF PLUTONIUM OXIDE-CONTAINING NUCLEAR FUEL COMPACTS. St. Pierre, Philippe D. S. (to General Electric Co.). U. S. Patent 3,168,601. Feb. 2, 1965. Filed Oct. 28, 1960.

A process is described for the production compacts of $PuO_2$ or $Pu_2O_3$ combined with $ThO_2$ or $UO_2$ having at least 95% density that are suitable for use as fuel elements. A thermally decomposable compound, such as oxalates, carbonates, or hydroxides, of the metal(s) to be used in the compact are compacted under a pressure of ½ to 5 T/ in². The compact is heated in a wet $H_2$ atmosphere at a rate of 25°C/hr up to 700°C to decompose the metal compounds. After decomposition, the heating is continued at 100°C/hr to a sintering temperature of at least 1500 to 1700°C, and this temperature is maintained for 8 hr. The sintered compact is cooled in a dry $H_2$ atmosphere. (B.L.M.)

**32715** METHOD OF REINFORCING GRAPHITE ARTICLES BY DEPOSITING FUSED METALS. Ando, Yoshio; Fujimura, Tadato (to Japan Atomic Energy Research Inst.). U. S. Patent 3,170,058. Feb. 16, 1965. Priority date June 16, 1961, Japan.

Graphite articles may be reinforced by depositing fused Fe–Ni alloy on the outer surface of the structure to clamp the graphite article by shrinkage stress caused when the fused metal cools. A wire or powders of the alloy is attached to the structure and heated by an electric arc or a welding torch in an inert atmosphere. (A.G.W.)

## Properties and Structure

*Refer also to abstracts 32503, 33389, and 33582.*

**32716** (AAEC/TM-290) THE VARIATION WITH TEMPERATURE AND POROSITY, OF THE MODULI OF RUPTURE AND ELASTICITY OF "STANDARD" ISOSTATICALLY PRESSED AND SINTERED BERYLLIA. Veevers, K.; Rotsey, W. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1965. 22p. Dep.(mn).

Some properties of isostatically pressed and sintered UOX beryllia, fabricated at Lucas Heights to a grain size of ≤3μ were measured. The modulus of rupture of material of density 2.86 to 2.90 g $cm^{-3}$ was measured in four-point bending over the temperature range 20°C to 1000°C. The data could be represented by the equation: $\sigma_f = 33{,}000 - 7.46T$ psi. The total variance was $19.5 \times 10^6$ psi made up of a "within" batch variance, of $15.8 \times 10^6$ psi and a "between" batch variance of $3.7 \times 10^6$ psi. The modulus of rupture at 20°C was measured on material with a total porosity range of 4 to 35 per cent; the data could be represented by the equation: $\sigma = \sigma_0 \exp(-2.44P)$ psi. The modulus of elasticity was measured in four-point bending on 97.5 per cent dense material and the data could be represented by the equation: $E = (51.45 \times 10^6) + (1.264 \times 10^2 T) - (1.442 \times 10^{-1} T^2) - (2.595 \times 10^{-3} T^3)$ psi. The modulus of elasticity was measured as a function of porosity in the range 2 to 36.4 per cent; the data could be represented by the equation: $E = E_0 (1 - 1.47P) \times 10^6$ psi. (auth)

**32717** (AD-425912) MATERIALS INVESTIGATION, SPUR PROGRAM. PART III. FATIGUE EVALUATION OF Mo + 0.5 w/o Ti. Salley, R.; Kovacevich, E. (Garrett Corp., Phoenix, Ariz. AiResearch Mfg. Div.). Aug. 1963. Contract AF33(657)-8954. 16p. (ASD-TDR-63-270(Pt. III)) $2.60(CFSTI).

The results of experimental investigations to evaluate the fatigue properties of Mo–0.5 wt % Ti alloy are presented. Tests were conducted with specimens in K vapor and in vacuum at 1500 and 2000°F to determine what effect, if any, the K vapor would have on the fatigue properties. The results indicate that the fatigue strength of Mo–0.5 wt % Ti is reduced. (auth)

**32718** (AD-608398) NIOBIUM, DATA SHEETS. Grigsby, Donald L. (Hughes Aircraft Co., Culver City, Calif. Electronic Properties Information Center). Nov. 1964. Contract AF33(615)-1235. 111p. (DS-141) $4.00 (CFSTI).

A compilation of a wide range of electrical and magnetic properties for Nb of various purities in bulk and film form is presented. Electrical properties include conductivity, resistivity, Hall coefficient and transition temperature. Magnetic properties include susceptibility, hysteresis and threshold field. Emission and energy data include thermionic properties, photon emissivities, absorption and energy gap. Debye temperature and thermal conductivity data are also given. Each property is compiled over the widest possible range of parameters from references obtained in a thorough literature search. A summary of physical properties was added. (auth)

**32719** (AD-609727) VANADIUM ALLOY STUDIES. Bimonthly Report, October 1–November 30, 1964. Holtz, F. C. (IIT Research Inst., Chicago, Ill.). Dec. 11, 1964. Contract NOw-64-0239-c. 16p. (IITRI-B6021-5) $1.00 (CFSTI)

Progress in the development of Va alloys having improved short-time creep properties at temperatures up to 2400°F is reported. The alloy V-40Nb-30Ta-1Ti and this base complexed with various combinations of B, C, Hf, and Si were readily cold rolled after thermal homogenization of the arc-melted ingots; in some cases a 2400°F press forging operation was required for initial ingot breakdown. Most of the compositions exhibited twinning when deformed at room temperature, and unusually high room-temperature strength and ductility were obtained; the alloy containing 0.23 wt % Si and 0.075 wt % C had a density-corrected ultimate strength of 650,000 psi/(lb/in³), with 24% elongation. Addition of 1.5 wt % Hf and 0.075 wt %C produced in a substantial increase in the 2200°F creep resistance of the V-40NB-30Ta-1Ti base. (auth)

**32720** (AD-609815) STUDIES OF REFRACTORY ALLOY SHEET MATERIALS. Final Report, March 15, 1963–December 15, 1964. Barr, Robert Q.; Semchyshen, M. (Climax Molybdenum Co. of Michigan, Detroit). Dec. 31, 1964. Contract NOw 62-0419-c. 90p. $3.00 (CFSTI)

Pilot lots of 0.05-in.-thick sheet were rolled from ingots of the following compositions: (1) Mo–1.59% Nb–0.52% Ti–0.21% Zr–0.068% C, (2) Mo–1.30% Ti–0.35% Zr–0.093% C, (3) W–3.10% Mo–0.04% Zr–0.001% C. The use of solution or solution and aging thermal treatments at the extruded billet stage (prior to rolling to sheet) markedly increased the recrystallization temperature and the elevated-temperature tensile and creep-rupture strengths of the two molybdenum-base alloys. Tensile strengths of 55,000 psi at 3000°F and 13,600 psi at 3500°F were observed for the tungsten-base alloy. The W–Mo–Zr alloy sheet exhibited higher strength : density ratios at 3000°F than any of the molybdenum-base alloys evaluated. Creep-

rupture strengths of both molybdenum- and tungsten-base alloy sheet materials were affected by reactions between the specimen surfaces and the test atmosphere (<.0004 torr). The molybdenum-base alloys experienced measurable decarburization during tests at 2400 and 3000°F. (auth)

**32721** (AD-610016) MICROSTRUCTURE OF URANIUM STEELS. Reed, Everett L. (Watertown Arsenal Labs., Mass.). Apr. 1961. 15p. $1.00(CFSTI).

Metallographic studies were conducted on small vacuum-melted steel ingots made from a 0.59% carbon ingot from base to which uranium was added in the range of 1.33 to 2.37%. It was determined that uranium in excess of 1.33% resulted in an iron–uranium complex carbide segmentation which persisted in the structure after austenitizing at 1500°F. An increase of uranium in the range studied failed to increase the hardness of the annealed steels but produced a noticeable increase in hardness of the quenched series. Traces of fine pearlite were presented in some of the quenched uranium steels. An increase in carbon content of these steels may have contributed to the increase in hardness. The mechanical properties of these high uranium steels would be impaired by the presence of these iron-uranium complex carbides in the grain boundaries. (auth)

**32722** (AD-610361) GROWTH AND CHARACTERIZATION OF SINGLE CRYSTALS OF RARE EARTH COMPOUNDS. Sixth Quarterly Technical Report. [Westinghouse Electric Corp., Pittsburgh, Pa.]). [1964]. Contract AF49(638)-1245. 10p. $1.00(CFSTI)

Large size single crystals of EuS were grown from the melt. Also crystals of Si-doped $CrBr_3$ having the shape of semispheres were epitaxially grown upon the (111) surface of single crystal substrates of $CaF_2$. Work was continued on the electric conductivity of La-doped EuS. The effect of impurity scattering on the electric resistivity of Gd was studied for the solute elements of La and all rare earths except Pm, Eu, and Yb. The study of the magnetic structures of the CrTe–CrSb system was confined to the CrTe-rich solutions. (CFSTI)

**32723** (AECL-2234) THE SIGMA PHASE AND ITS METALLOGRAPHIC IDENTIFICATION IN TYPE 310 STAINLESS STEEL. Roberge R.; Lawson, V. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 46p. Dep.; $1.00(AECL).

A literature review of the Sigma phase and its effects on the room and elevated-temperature mechanical properties of stainless steels is presented. Included is a review of identification methods. The known etchants and their action on Sigma particles was investigated. The best etchant for the identification of Sigma in type 310 stainless steel was found to be an electrolyte of 10N potassium hydroxide in which the specimen was etched anodically for 5 seconds at 1.5 volts. (auth)

**32724** (AFML-TR-65-99) THERMOPHYSICAL AND TRANSPORT PROPERTIES OF LIQUID METALS. Tepper, F.; Zelenak, J.; Roehlich, F.; May, V. (MSA Research Corp., Callery, Pa.). May 15, 1965. Contract AF33(615)-1273. 25p.

Selected physical property measurements on Rb and Cs metals were performed to temperatures of 2000°F. These measurements included characterization of liquid, vapor, and transition properties. Some of the liquid properties of K, Na, Li, and eutectic NaK alloy were measured. The density of liquid K, Na, and Li was determined to 2000°F. Equations relating density to temperature are given for each of the fluids, and the density and these values are compared to density temperature relations obtained earlier for Rb and Cs. The electric resistivity of K, Na, Li, and eutectic NaK was determined to 2000°F. The thermal conductivity of these liquids was computed by using the Wiedemann-Franz-Lorentz relation. The surface tension of Rb and Cs was measured to temperatures of ~1850°F, using the maximum bubble pressure method. Surface tension of Cs did not appear to change with the addition of known quantity (130 ppm) of $O_2$. The viscosity of liquid Cs was measured to 2000°F, and equations are given for viscosity of Rb and Cs. The vapor pressure of eutectic NaK was determined to 1935°F and vapor pressure was found to follow Raoult's Law rather closely. Equations of state were derived for Rb and Cs vapor, using experimentally obtained PVT data. The heat of vaporization was computed from the Clapeyron Equation, and Mollier Diagrams for Rb and Cs were constructed. Critical temperatures of 3465 and 3350°F were estimated respectively for Rb and Cs from the saturated liquid and saturated vapor temperature-entropy equations. The vapor viscosity of Rb was measured at 1330 and 1505°F, and is respectively 269 and 295 micropoises. A method was chosen for measurement of thermal conductivity of alkali metal vapor. Complete construction of the device was delayed while awaiting receipt of feedthroughs which are to be fabricated using sapphire as an insulator. (auth)

**32725** (ANL-7020(p.150-64)) HIGH TEMPERATURE REACTOR MATERIALS DEVELOPMENT. (Argonne National Lab., Ill.).

The current status of high-temperature phase relations and thermodynamic properties in the $U-UO_2$ system is reviewed. Some useful theoretical guidelines for experimentation are developed. Recent experimental results on the vapor pressure, vaporization, and phase diagram of $U-UO_2$ are discussed. Some results on the phase diagram study of the U–US system are described. (D.L.C.)

**32726** (BNWL-32) THE STEADY-STATE CREEP OF HIGH-PURITY PLUTONIUM. Nelson, R. D.; Bierlein, T. K.; Bowman, F. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT (45-1)-1830. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Compressive creep experiments were performed on the six allotropes of Pu at constant stress and isothermal conditions. The creep rates were measured for the allotropes formed by heating a low temperature stable allotrope and by cooling a high temperature stable allotrope. The average activation energies for steady-state creep were determined and the activation energies for self-diffusion were calculated from an empirical expression that utilizes modulus compensated creep rates. (W.L.G.)

**32727** (COO-578-P27-7) YIELD PHENOMENA AND FRACTURE OF HYDRIDED ZIRCONIUM. Quarterly Report, January 1, 1965–March 31, 1965. Weinstein, D. (IIT Research Inst., Chicago, Ill.). Apr. 30, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-578. 22p. (IITRI-B6035-7). (EURAEC-1395). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A program is in progress for the study of discontinuous yield phenomena in polycrystalline zirconium. It was suggested that yield point occurrence might be explained in terms of current models for discontinuous yield in body-centered cubic crystals, and data are being obtained which could lend evidence toward showing this relationship. Thus far, yield point occurrence in high-purity polycrystalline zirconium appears to be strongly dependent on average grain size. An explanation for this behavior under the current concepts for yield in body-centered cubic crystals was presented, but additional data are necessary. (auth)

**32728** (DRI-1092-210) DETERMINATION OF PHASE EQUILIBRIA IN THE SYSTEM $BeO-ThO_2$. Third Quarterly Report. Otto, Henry E. (Denver Research Inst., Univ. of Denver, Colo.). June 15, 1965. Contract AT (11-1)-1092. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The eutectic composition and temperature of the BeO–$ThO_2$ system was established at 70 mole % BeO (18.1 wt %) at 2155°C. The limits of solid solubility were 0.25 mole % BeO in $ThO_2$ and 0.05 mole % $ThO_2$ in BeO; both at temperatures approaching the eutectic. (W.L.G.)

**32729** (DRI-1092-211) STUDIES OF THE EFFECT OF INTERSTITIAL ADDITION ON THE PHASE EQUILIBRIA OF THE NIOBIUM-RICH REGION OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. Quarterly Progress

Report No. 3. Yamamoto, Albert S. (Denver Research Inst., Univ. of Denver, Colo.) June 1965. Contract AT(11-1)-1092. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress in the investigation of the effect of C additions on the phase relationships of the Nb-rich region of the Nb–W–Hf and N–W–Zr alloy systems is reported. Isothermal annealing at 1600 and 1300°C of the Nb–W–Hf with nominal C additions of 0.5, 0.25, 0.1, 0.05 and 0.01 wt % were completed. Microscopic examination of the annealed alloy structure showed a second phase or phases present in all the alloys investigated at both temperatures except a Nb–0.5 W–0.5 Hf–0.01 C, which showed nearly a single-phase structure at 1600°C. A limited number of the Nb–W–Zr alloys containing nominal 0.25, 0.1, 0.05, and 0.01 wt % were heat treated isothermally at both 1600 and 1300°C. All the annealed and quenched alloys examined metallographically exhibit the structures with precipitates, varying in the amounts and mode of precipitation. X-ray diffraction studies of the carbon-bearing alloys in the two systems are in progress. (auth)

**32730** (DRI-1092-212) PHASE EQUILIBRIA OF THE TANTALUM-RICH REGION OF THE TANTALUM–TUNGSTEN–HAFNIUM AND TANTALUM–TUNGSTEN–ZIRCONIUM SYSTEMS. Quarterly Progress Report No. 3. Klodt, Donald T.; Yamamoto, Albert S. (Denver Research Inst., Univ. of Denver, Colo.). June 1965. Contract AT (11-1)-1092. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are presented on the progress of the long-term, high temperature vacuum annealing treatments and the metallographic examination of the isothermally annealed alloys in the Hf–Ta–W and Ta–W–Zr systems. (W.L.G.)

**32731** (EURAEC-1349) STUDY OF EMBRITTLEMENT BY PLASTIC FATIQUE OF STEELS FOR REACTOR VESSELS. Quarterly Report No. 5, January 1–March 31, 1965. (Centre National de Recherches Metallurgiques, Liege (Belgium)). Apr. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 005-63-12-TEEB. 47p. (EUR-2324). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The embrittlement by plastic fatigue of three steels, was studied using the Side Bend Test after fatigue by alternating bending and the impact strength tests on Charpy V test-pieces, taken from the samples previously submitted to monoaxial plastic fatigue under tension and compression. The tests indicate a pronounced influence of small numbers of fatigue cycles. In some cases, the imposition of direction of maximal stress for damage by bend fatigue led to perceptible rises of the transition temperature. The maximum values of the shift of the Side Bend Test transition curve never exceeded 30°C for tests at 20 and 300°C. (auth)

**32732** (GEAP-4745) STABILITY OF HIGH-NICKEL ALLOYS IN SUPERHEATED STEAM. Comprelli, F. A.; Wolff, U. E. (General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.). Nov. 1964. Contract AT(04-3)-189. 94p. Dep.; $3.00(cy), 2(mn) CFSTI.

The room temperature tensile properties and microstructural characteristics of superheat cladding materials were evaluated as a function of exposure at 1050 and 1150°F for periods up to 10,000 hours. The alloys of interest for superheat reactor applications are the solid solution alloys: Hastelloy-X, Inconel-625, Incoloy-800, Incoloy-825, and Inconel-600. These alloys, when subjected to prolonged exposure at these temperatures, exhibit metallurgical changes which affect the properties of the material. The test results indicated that each alloy was subject to some degree of thermal instability after very long exposure at temperature, as evidenced by carbide precipitation, a progressive strengthening of the alloy, and a corresponding reduction in ductility. (auth)

**32733** (NAA-SR-11047) SOME HIGH TEMPERATURE MECHANICAL PROPERTIES OF ZIRCALOY-2, TYPE 304 STAINLESS STEEL, AND AM-350 STAINLESS STEEL. Stone, D. H. (Atomics International, Canoga Park, Calif.). June 15, 1965. Contract AT(11-1)-Gen-8. 28p. Dep. (mn); $2.00(cy), 1(mn) CFSTI.

Results of high temperature strength investigations of Zircaloy-2, type 304, and AM-350 stainless steels are given. Creep rates and the creep activation energy of Zircaloy-2 were determined at 1200 and 1300°F. A correlation between carbon, nitrogen, phosphorous, and sulphur and the stress-rupture strength was found for Type 304 stainless steel. No effects of overaging were seen in AM-350 stainless steel in either tensile or creep tests near the aging temperature. (auth)

**32734** (NMI-7075) METALLURGICAL INVESTIGATION OF U–350 Si–1000 Mo ALLOY. White, A. M. (Nuclear Metals, West Concord, Mass.). May 10, 1965. Contract AT(30-1)-1565. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Hardness behavior and microstructures were investigated for a U alloy containing approximately 350 ppm Si and 1000 ppm Mo. The hardness data for different conditions were compared with those for the corresponding binary alloys and for eleven alloys containing a total of at least 1000 ppm of alloying elements. The U–Si–Mo alloy exhibits solution hardening, which is lost during prolonged exposure at 500 or 600°C. (auth)

**32735** (NP-tr-1236(p.41-52)) THE STRUCTURE AND PHASE COMPOSITION OF BERYLLIUM PLATING ON COPPER OBTAINED BY ELECTROLYSIS OF MOLTEN SALTS. Anfinogenov, A. I.; Belyaeva, G. I.; Smirnov, M. V.; Ilyushchenko, N. G.

A study was made of the relation between the cathode potentials, phase composition, and structure of beryllium platings on copper obtained by electrolysis of molten salts. It was established that cathode deposition of beryllium onto copper results in the formation of platings consisting of one phase or several phases. Their structure is determined by the electrolysis conditions (current density, temperature, and time). It was shown that the electrolysis conditions promote the rapid formation and growth of the $\beta$-phase most. (auth)

**32736** (NP-tr-1236(p.66-73)) INVESTIGATION OF STRUCTURAL COMPONENTS AND ELECTRICAL CONDUCTIVITY AND ITS CHARACTER IN THE SYSTEMS $ZrO_2$–CaO–NiO AND $ZrO_2$–CaO–$Fe_2O_3$. Neuimin, A. D.; Pal'guev, S. F.; Strekalovskii, V. N.; Burov, G. V.

A study was made of the structure and electrical conductivity and its nature for a series of oxide mixtures from the systems $ZrO_2$–CaO–NiO and $ZrO_2$–CaO–$Fe_2O_3$ with the constant ratio $ZrO_2$ : CaO = 85 : 15. It was established that NiO does not dissolve in the mixture $ZrO_2$ + CaO in appreciable amounts, while solid solutions are formed when $Fe_2O_3$ is added with the iron ions partly occupying lattice points and partly lying in interstitial positions in the cubic lattice of the solid solution. Measurement of the electrical conductivity and investigation of its character by the emf method confirm the results of investigating the structure of the mixture. With an increase in the NiO content of the mixture, the electrical conductivity falls montonically and remains practically purely ionic, like the mixture $ZrO_2$ + CaO without additives, up to an NiO content of 30 mole % over a wide range of temperatures. The introduction of $Fe_2O_3$ into the mixture up to 6.0 mole % of $FeO_{1.5}$ does not lead to an appreciable decrease in electrical conductivity and does not change the character of the latter (in an atmosphere of oxygen or air). With a further increase in the $Fe_2O_3$ content, the fraction of electronic conductivity increases. (auth)

**32737** (NP-tr-1236(p.74-8)) TRANSPORT NUMBERS IN THE SYSTEMS $CeO_2$–BeO, $CeO_2$–MgO, $CeO_2$–CaO, AND $CeO_2$–SrO. Yushina, L. D.; Pal'guev, S. F.

The transport numbers of a series of compositions from the oxide mixtures $CeO_2$–MeO (where MeO is BeO, MgO, CaO, and SrO) were determined by a modified gravimetric method. It was found that in all the mixed oxides investigated, including strontium cerate ($SrCeO_3$), the ionic component of the electrical conductivity is connected with mobility of the oxygen ions. The experimental data obtained confirm a hypothesis put forward previously that solid solutions of the substitution-subtraction type are

formed in the system $CeO_2$–BeO. Despite the very slight solubility, it has a very strong effect on the electrical properties of the mixed oxides. (auth)

**32738** (NP-tr-1236(p.79-91)) REDUCTION OF CERIUM DIOXIDE IN OXIDE MIXTURES OF THE SYSTEM $CeO_2$–$La_2O_3$ AND ELECTRICAL CONDUCTIVITY OF THE MIXTURES. Neuimin, A. D.; Pal'guev, S. F.; Chebotin, V. N.

An investigation was made of the reduction and electronic conductivity of the system $CeO_2$–$La_2O_3$ in relation to temperature, the $La_2O_3$ content, and the composition of the gas phase with which the crystals investigated were in thermodynamic equilibrium. It was established that the isotherms of the degree of reduction against composition, $CeO_{1.5}$ concentration against composition, and conductivity against composition have maxima in the region of 15–20 mole % $LaO_{1.5}$. It was established that the reduction and electronic conductivity increase exponentially with temperature and their temperature coefficients fall with a rise in the $LaO_{1.5}$ content up to ~20 mole % and increase with a further increase in the $LaO_{1.5}$ content. This results in the presence of the maxima on the isotherms mentioned. It was shown that the decrease in the temperature coefficients of the reduction and electrical conductivity with an increase in the additive concentration is explained well qualitatively by the coulombic interaction of the structural defects of the crystal. The activation energy of the electrons was determined and their mobility estimated. It was established that the reduction and electronic conductivity of the solid solutions investigated decreases with an increase in the partial pressure of oxygen in the gas phase. (auth)

**32739** (NP-tr-1236(p.92-6)) NATURE OF THE ELECTRICAL CONDUCTIVITY OF SOLID SOLUTIONS OF $Bi_2O_3$–SrO. Neuimin, A. D.; Yushina, L. D.; Ovchinnikov, Yu. M.; Pal'guev, S. F.

Electromotive forces were used to investigate the nature of the electrical conductivity of solid solutions of $Bi_2O_3$–SrO in contact with high (oxygen–air) and low (air–CO + $CO_2$) oxygen contents. It was established that the solid solutions 0.8 $Bi_2O_3$–0.2 SrO and 0.85 $Bi_2O_3$–0.15 SrO are solid electrolytes with a considerable fraction of ionic conductivity under certain conditions. (auth)

**32740** (NP-tr-1239) THE STRENGTH AND DEFORMATION PROPERTIES OF SINTERED ALUMINA BODIES AS A FUNCTION OF THEIR COMPOSITION AND STRUCTURE. Dawihl, W.; Doerre, E. Translated by Nowottny, H. (Atomic Energy Research Establishment, Harwell (England)), from Ber. Deut. Keram. Ges., 41: No. 2, 85-96(1964). 43p. Dep.(mn); $4.60(fs), $1.49(mf) JCL.

An investigation was conducted to find out if any diffusion processes are detectable in pure alumina at temperatures below 1200°C. The starting materials were powders and the method employed was to measure the specific surface and to determine, by x ray, lattice stresses and their release after different heat treatments. Sintered bodies were investigated at room temperature, at 500 and 1000°C for their crushing strength, impact bending strength, shinkage, and hardness in two series of experiments: first varying the MgO and $SiO_2$ content and keeping the firing conditions constant and second varying the firing conditions and keeping the composition constant. It was found that there is a definite relationship between the measured temperature-dependent properties, on the one hand, and composition, structure, and porosity, on the other. The experiments were extended to include electron-microscope observations of alumina surfaces that had been suitably prepared by heat treatment and etching. Comparison between sintered bodies of tungsten carbide with small additions of cobalt and sintered alumina bodies with small additions of MgO reveals many similarities. (auth)

**32741** EFFECTS OF HEAT ON CONCRETE STRENGTH. Engineering, 197: 302(Feb. 21, 1964).

Concrete specimens were tested after exposure to temperatures up to 150°C. The concrete was made with Portland cement and limestone aggregate, and the test specimens consisted of hollow and solid cylinders. Loading to failure after heating tests was always carried out at a temperature below 30°C and at a rate of 2,000 lb/in.$^2$/min. Triaxial stress distributions were applied by a hydrostatic pressure of 480 lb/in.$^2$. Strength loss after 18 hr at temperature equilibrium was less for hollow cylinders tested at 150°C than for those tested at 100°C. The strength at the end of the test was dependent on moisture content of the concrete. Tests on solid cylinders indicated that when the effect of strength gain due to moisture loss was eliminated, there was no recovery of strength at 150°C. (M.C.G.)

**32742** CARBON DIFFUSION INTO $\beta$ ZIRCONIUM. Pavlinov, L. V.; Bykov, V. N. Fiz. Metal. i Metalloved., 19: 397-400(Mar. 1965). (In Russian)

Data on $^{14}C$ diffusion in $\beta$ zirconium at 900 to 1200°C are described by the formula $D = 0.0048 \exp(-26{,}700/RT)cm^2/sec$. The temperature dependence parameters of the carbon coefficients in zirconium ($D_0$ and $\Delta H$) agree with the data on carbon diffusion in other body-centered metals and with the magnitudes calculated on the basis of Wert-Zener theory. The activation energy and the frequency factor of the carbon and nitrogen diffusion in zirconium are similar to the magnitudes of zirconium self-diffusion. (R.V.J.)

**32743** MAGNETIC PROPERTIES OF Er–Sc. Pop, I.; Chechernikov, V. I.; Naumkin, O. P.; Savitskii, E. M. (Moscow State Univ.). Fiz. Metal. i Metalloved., 19: 466-8(Mar. 1965). (In Russian)

Physicochemical analysis was made of 99.18% pure Er and 99.23% pure Sc at various temperatures. Microstructure, x-ray diffraction, and thermal analyses of eight specimens (with 1.3, 29.9, 38.1, 44.5, 63.1, 77.5, 86.5, and 95 at % Sc) showed that at room temperature the Sc–Er alloy formed continuous series of solid solutions. The temperature dependence curves of magnetic suseptibility as function of temperature indicate the possible existence of antiferromagnetic exchange reaction in Er–Sc alloys. In alloys with large content of Er the antiferro magnetism is due to the complex spin or spiral structure of Er in which the antiferro magnetic reaction takes place along with the positive reaction. (R.V.J.)

**32744** DIFFUSION SATURATION OF MOLYBDENUM WITH CARBON. Shcherbedinskaya, A. V.; Minkevich, A. N. Izv. Vysshikh Uchebn. Zavedenii, Chernaya Met., No. 11, 185-8(1964). (In Russian)

Analyses were made of diffusion coefficients and diffusion activation energies of C and Mo in a MoC compound from 900 to 1600°C using $^{14}C$ and $^{99}Mo$. (Rev. Metal Lit., 22: No. 3, (Mar. 1965))

**32745** PRELIMINARY MAGNETIC RESONANCE AND SUSCEPTIBILITY STUDY OF $UO_2 \cdot xH_2O$. Komac, M.; Pintar, M.; Kolar, D. (Institut "J. Stefan," Ljubljana, Yugoslavia). J. Chem. Phys., 43: 1073-4(Aug. 1, 1965).

Preliminary measurements showed that the susceptibility decreases as x increases in $UO_2' \times H_2O$ for X = 1 to 2.37. The oxidation of $U^{4+}$ to $U^{6+}$ reduced the system susceptibility, but the difference between the susceptibilities of various samples having different O/U ratios was too great to be accounted for only by the different susceptibilities of $U^{4+}$ and $U^{6+}$ ions. It was concluded that some other mechanism reduced the susceptibility in some samples. (F.J.H.)

**32746** THE REACTIONS OF TRANSURANIUM OXIDES WITH ALKALI OXIDES. I. TERNARY OXIDES OF HEXAVALENT TRANSURANIUM WITH LITHIUM AND SODIUM. Keller, C.; Koch, L.; Walter, K. H. (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 1205-23 (June 1965). (In German)

In the system alkali oxide–transuranium oxide–oxygen, ternary oxides containing hexavalent transuranium elements were prepared by reactions in the solid state. Depending on reaction conditions, the following compounds were obtained: $Na_2Np_2O_7$, $\alpha$-$Na_2NpO_4$, $Li_4XO_5$(X = Np, Pu, and Am), $\alpha$-$Na_4XO_5$(X = U, Np, Pu, and Am), $\beta$-$Na_4XO_5$(X = Np and Pu), $Li_6XO_6$(X = Np, Pu, and Am), and $Na_6XO_6$(X = Np, Pu, and Am). These compounds were isotypic with the

uranates of corresponding formula types. For $\alpha$-$Na_4XO_5$ a NaCl-structure with statistical distribution of the metal ions was found. The thermal stability of these compounds decreased in the order U–Np–Pu–Am. With the exception of the ternary oxides of the system $Na_2O/NpO_3$ the alkali-transuranates (VI) formed molecular solutions in water. In the case of the $Me_6XO_8$ compounds, this behavior was irreversible as can be explained by the crystal structure. The thermal, hydrolytic, and structural properties are described in detail and compared with the uranates (VI). The unisotropic swelling of the lattice of these compounds due to its $\alpha$-radiation is discussed for $Li_4AmO_5$. (auth)

**32747** THE REACTIONS OF TRANSURANIUM OXIDES WITH ALKALI OXIDES. II. TERNARY OXIDES OF PENTAVALENT TRANSURANIUM AND PROTACTINIUM WITH LITHIUM AND SODIUM. Keller, C.; Koch, L.; Walter, K. H. (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 1225-32(June 1965). (In German)

The following ternary oxides, containing pentavalent transuranium elements, were obtained by thermal decomposition of alkali transuranates (VI), by symproportionation of alkali transuranates (VI) + transuranium-dioxide, and by oxidation of transuranium dioxide–alkali oxide mixtures: $Li_3XO_4$(X = Np, Pu, Am), $Na_3XO_4$(X = Np, Pu, Am), and $Li_7XO_6$(X = Np, Pu, Am). Compounds of the type $MeXO_3$ could not be synthetized. The alkali transuranates (V) decomposed into $XO_2 + Me_2O$ above characteristic temperatures, the thermal stability decreasing in the order Np–Pu–Am. In the case of $Na_3AmO_4$, thermal decomposition led to $Na_2AmO_3$ as an intermediate compound. The chemical and structural properties of the alkali-transuranates (V) are discussed and compared with the corresponding uranates (V). To obtain further data in this line, the following alkali protactinates (V) were prepared by thermal reaction of $Pa_2O_5$ with $Me_2CO_3$: $LiPaO_3$, $Li_3PaO_4$, $Li_7PaO_6$, $NaPaO_3$($GdFeO_3$–structure), and $Na_3PaO_4$ ($Li_3SbO_4$-structure). (auth)

**32748** THE REACTION OF DIOXIDES OF ELEMENTS THORIUM TO AMERICIUM WITH NIOBIUM AND TANTALUM PENTOXIDES. Keller, C. (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 1233-46(June 1965). (In German)

The following ternary oxides of the system Me–X–O (Me = Th, Pa, U, Np, and Pu and X = Nb, Ta) could be obtained by solid state reactions: $ThO_2 \cdot 2Nb_2O_5$; $ThO_2 \cdot 2Ta_2O_5$; ($\alpha + \beta$)-$2ThO_2 \cdot Nb_2O_5$; $2ThO_2 \cdot Ta_2O_5$; $PaO_2 \cdot 2Nb_2O_5$; $PaO_2 \cdot 2Ta_2O_5$; $PaO_{2.5} \cdot 1.5Nb_2O_5$; $PaO_{2.5} \cdot 1.5Ta_2O_5$; $UO_2 \cdot 2Nb_2O_5$; $UO_{2.67} \cdot 1.5Nb_2O_5$; $UO_{2.67} \cdot 0.5Nb_2O_5$; $UO_2 \cdot 2Ta_2O_5$; $UO_{2.67} \cdot 1.5Ta_2O_5$; $UO_{2.67} \cdot 0.5Ta_2O_5$; $NpO_2 \cdot 1.5Nb_2O_5$; $NpO_2 \cdot 2Nb_2O_5$; $NpO_2 \cdot 2Ta_2O_5$; $PuO_2 \cdot 2Nb_2O_5$; and $PuO_2 \cdot 2Ta_2O_5$. The compounds of the type $MeO_2 \cdot 2X_2O_5$ possess a structure deduced from the perovskite lattice; the $MeO_{2+y} \cdot 1.5X_2O_5$ compounds have a hexagonal type of structure. The phase diagram of the system $ThO_2$–$Nb_2O_5$ confirmed the ternary oxides of this system. The solid state reactions of $AmO_2$ and $CeO_2$ with $Nb_2O_5$ and $Ta_2O_5$ (molar ratio 1:1.5) yielded ternary oxides of the type $MeO_{1.5} \cdot 1.5X_2O_5$ with a structure also deduced from the perovskite lattice. Reaction conditions and chemical and structural properties of the compounds are discussed. (auth)

**32749** TERNARY OXIDES OF AMERICIUM AND SOME RARE EARTHS OF THE TYPE $A^{III}BO_3$. Keller, C.; Walter, K. H. (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 1247-51(June 1965). (In German)

The following ternary oxides of americium and some rare earths were obtained by solid-state reactions: $AmBeO_3$ (Aragonite structure), $AmAlO_3$ ($LaAlO_3$ structure), $AmVO_3$ ($GdFeO_3$ structure), $Me_2O_3 \cdot 3Nb_2O_5$ (Me = Am, La to Nd) and $Me_2O_3 \cdot 3Ta_2O_5$ (Me = Am, Y, La to Er), the last two types having a structure deduced from the perovskite-lattice according to the formula $Me^{III}_{0.33}XO_3$. Reaction conditions, properties, and lattice constants of these ternary oxides are discussed. (auth)

**32750** PREPARATION, LATTICE CONSTANTS, AND CHEMICAL PROPERTIES OF SOME TERNARY OXIDES OF PLUTONIUM, AMERICIUM, AND CURIUM OF THE TYPE $Me^{III}X^{V}O_4$. Keller, C.; Walter, K. H. (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 1253-60(June 1965). (In German)

The following compounds of neptunium, plutonium, americium, and curium could be obtained by precipitation or solid state reactions: $NpP_2O_7$ ($\alpha$-$ThP_2O_7$ structure); $AmPO_4 \cdot 0$ to $0.5H_2O$ ($LaPO_4 \cdot 0$ to $0.5H_2O$ structure); $CmPO_4$, $AmAsO_4$, $PuAsO_4$, and $AmPO_4$ ($CePO_4$ structure); $PuNbO_4$, $AmNbO_4$, $CmNbO_4$, $AmTaO_4$, and $CmTaO_4$ ($\beta$-fergusonite type); $PuTaO_4$ ($PrTaO_4$ type); $(Pu_{0.5}, Pa_{0.5})O_2$, $(Am_{0.5}, Pa_{0.5})O_2$, and $(Cm_{0.5}, Pa_{0.5})O_2$ ($CaF_2$ structure); $Ba(Me_{0.5}, X_{0.5})O_3$ (Me = Pu and Am; X = Nb, Ta, and Pa with ordered perovskite structure); and $AmNbTiO_6$ and $Am\,TaTiO_6$ (Priorite type). These compounds are mostly isotypic with the compounds of rare earth elements having the same ionic radius. The existence of $(Ac_{0.5}, Pa_{0.5})O_2$ could be established by radiochemical methods. Reaction conditions, chemical properties, and lattice constants of these compounds are discussed. (auth)

**32751** PHASE RELATIONS BETWEEN IRIDIUM AND THE SESQUIOXIDES IN AIR. Schneider, S. J.; Waring, J. L.; Tressler, R. E. J. Res. Natl. Bur. Std., 69A: 245-54(May-June 1965).

A study was made by x-ray diffraction analysis of the reactions that occur in an air environment between Ir and $IrO_2$ and each of the following: $Nd_2O_3$, $Sm_2O_3$, $Eu_2O_3$, $Gd_2O_3$, $Dy_2O_3$, $Ho_2O_3$, $Y_2O_3$, $Er_2O_3$, $Tm_2O_3$; $Yb_2O_3$, $Lu_2O_3$, $In_2O_3$, $Sc_2O_3$, and $Al_2O_3$. In air Ir oxidizes at low temperatures to form $IrO_2$ which in turn dissociates at 1020°C. The pseudo binary $Nd_2O_3$–$IrO_2$ was studied in detail inasmuch as it typified many of the $Ln_2O_3$–$IrO_2$ systems. Two compounds, $Nd_2O_3 \cdot 2IrO_2$ and $3Nd_2O_3 \cdot 2IrO_2$ occurred in the system. The former, a cubic pyrochlore type phase, dissociated on heating at 1190°C. The 3:2 compound dissociated to the solid phases, $Nd_2O_3$ and Ir, at 1300°C. Prior to dissociation, the 3:2 compound underwent an apparent polymorphic transition at 1195°C, which may be related to an oxygen loss. Up to at least 2000°C no further reaction occurred between Ir and $Nd_2O_3$. All B- and C-type rare earth oxides formed cubic pyrochlore type compounds with $IrO_2$. Each of these compounds subsequently dissociated on heating. No apparent reaction occurred between $IrO_2$ and either $In_2O_3$, $Sc_2O_3$, or $Al_2O_3$. (auth)

**32752** PHASE EQUILIBRIUM RELATIONSHIPS IN THE SYSTEM $Gd_2O_3$–$TiO_2$. Waring, J. L.; Schneider, S. J. J. Res. Natl. Bur. Std., 69A: 255-6(May-June 1965).

The phase equilibrium relationships for a major portion of the $Gd_2O_3$–$TiO_2$ system were determined in air, from a study of solid-state reactions and from fusion characteristics. Three intermediate phases, a 1:2 compound, a 1:1 compound, and a face-centered-cubic solid solution occurred in the system. The solid-solution phase was indicated on the phase diagram as existing from 33 to 40 mole % $TiO_2$, at 1750°C. This phase melted incongruently over a range of temperatures and compositions, from 1840°C, the peritectic temperature at 35 mole % $TiO_2$, to 1775°C at 40 mole % $TiO_2$, the incongruent melting temperature of $Gd_2O_3 \cdot TiO_2$. The minimum temperature of stability for the phase was 1600°C at 38 mole % $TiO_2$. The compound $Gd_2O_3 \cdot 2TiO_2$ had a cubic pyrochlore structure type with a = 10.181 Å and melted congruently at 1820°C. This phase apparently accepted up to about 3 mole % $TiO_2$ in solid solution at 1460°C. The compound $Gd_2O_3 \cdot TiO_2$, melted incongruently at 1775°C and had a reversible phase transition at 1712°C. The x-ray powder diffraction pattern of the high-temperature modification was indexed on the basis of a hexagonal cell a = 3.683 and c = 11.995 Å and was apparently related to the A-type rare earth oxide. The compositions $Sm_2O_3$:$TiO_2$ and $Eu_2O_3$:$TiO_2$ gave x-ray diffraction powder patterns with marked similarity one to the other as well as to both the high and low polymorphs of $Gd_2O_3 \cdot TiO_2$. The composition $Dy_2O_3$:$TiO_2$ formed sev-

eral phases, one of which was apparently related to the high-temperature polymorph of $Gd_2O_3 \cdot TiO_2$. (auth)

**32753** DIFFUSION STUDIES OF GOLD IN STEEL ST 60 AS A BASE FOR TRACER INVESTIGATIONS IN WEAR MEASUREMENTS. Pippel, W.; Mueller, K. (Technische Universitaet, Dresden). Kernenergie, 8: 250-3(Apr. 1965). (In German)

The diffusion coefficient of gold in the special steel St 60 was determined by the layer separation method in the temperature range of 950 through 1370°C. The gold was electrolytically plated on the steel samples, which were then annealed in a furnace having temperature control with an accuracy of ±1.5°C in an atmosphere of pure argon. The samples were divided by means of a special microtom (thickness of the layers from 10 through 20$\mu$) and activated in the core of the Rossendorf Research Reactor RFR. The counting rates of sample segments were determined by a gamma scintillation spectrometer of VA-M-16 type as well as the distribution of gold concentration in steel, and from this the diffusion coefficient was calculated. According to the statistical error calculus, the measuring values for the temperature range studied may be represented by the equation $D = (2.14 \pm 0.14) \times 10^{-4}\, e^{(35.7 \pm 1.8)/RT}$ [$cm^2\ sec^{-1}$]. The results may be the base of tracer studies of wear measurements in steels. (auth)

**32754** INVESTIGATION OF NEW COLUMBIUM-BASE ALLOYS. EQUIPMENT USED. FIRST RESULTS OBTAINED. Syre, R.; Cousserans, R.; Molinier, R. Metaux (Corrosion-Ind.), 39: 305-24(Sept. 1964). (In French)

Brinell and Vickers hardness, hot and cold workability, and speed of oxidation of experimental binary alloys containing Fe, Co, or Ni and quaternary alloys containing Ti, V, and Zr plus C added to provide a dispersed phase (zirconium–carbide) were determined. A Nb–(Mo + Cr) combination and a sintered alloy of Nb and $ThO_2$, were also studied. Studies were undertaken with a view to development of a refractory alloy suitable for use in gas turbines for trucks. (Rev. Metal Lit., 22: No. 3, (Mar. 1965))

**32755** STRUCTURE DATA OF NEW INTERMETALLIC COMPOUNDS. Parthe, E.; Hohnke, D.; Jeitschko, W.; Schob, O. (Univ. of Pennsylvania, Philadelphia). Naturwissenschaften, 52: 155(1965).

Structure data on the following compounds are tabulated: ScMg, ScAl, ScGa, $ScIn_3$, ScSi, ScGe, YGa, YGe, LaGa, LaSi, LaGe, CeSi, CeGe, PrSi, NdSi, SmSi, GdSi, GdGe, DySi, DyGe, HoSi, and ErSi. (J.S.R.)

**32756** IMPROVED IRON-BASE CLADDING ALLOY FOR WATER REACTORS. Allio, R. J.; Thomas, K. C. (Westinghouse Electric Corp., Pittsburgh). Nucleonics, 23: No. 6, 72(June 1965).

The properties of a class of austenitic iron-base alloys with nominal compositions of 16% Cr and 20% Ni with very low C and N contents for use as cladding material in water-cooled reactors are summarized, together with preliminary cladding tests. (D.C.W.)

**32757** PROPERTIES OF SINTERED CERIUM DIOXIDE CERAMICS. Akopov, F. A.; Poluboyarinov, D. N. (Mendeleev Inst. of Chemical Engineering, USSR). Ogneupory, No. 4, 37-42(1965). (In Russian)

The sintering of finely dispersed cerium dioxide takes place intensively in the interval from 1300 to 1500°C. In an atmosphere of inert gas and in vacuum, the sintered CeO is reduced with an altered crystal structure which is accompanied by the reduction of the refractory and thermomechanical properties of the material. The unreduced $CeO_2$ appears as a highly refractory material which, in oxidizing medium, can be used at temperatures higher than 1900°C. (tr-auth)

**32758** KINETICS OF GROWTH AND STRUCTURE OF THIN FILMS OF TIN. v[an] d[er] Waterbeemd, J. (Philips' Gloeilampenfabrieken, N. V., Eindhoven, Netherlands). Phys. Letters, 16: 97-9(May 15, 1965).

Thin films of tin were prepared by evaporation on to an amorphous substrate of carbon on glass, and the kinetics of growth and the structure of the films were studied with transmission electron microscopy. The usual series of stages were observed: nucleation, archipelago, labyrinth and closing. The results of the qualitative and quantitative examinations of the electron micrographs are reported. (L.B.S.)

**32759** ELECTRONIC PROPERTIES OF SURFACE LAYERS OF SILVER CHLORIDE. Snavely, B. A. (Cornell Univ., N. Y.). Phys. Status Solidi, 9: 709-19(1965).

Photoconductivity and luminescence produced by 0.2 $\mu$s x-ray pulses and thermally stimulated currents were measured between 80 and 260°K. The electron schubweg is controlled by traps, some of which (in excess of $10^{15}$ $cm^{-3}$) are deep and are destroyed by oxygen. The probability for radiative recombination is small compared to that for trapping. The mobility in oxygen-doped crystals is the same in the surface as in the bulk. Anomalies in the temperature dependence of the mobility are attributed to trapping and re-emission. (auth)

**32760** PHOTOELASTIC STUDY OF DISLOCATIONS IN COLORED LiF. Schaeffer, B.; Dupuy, C.; Saucier, H. (Faculte des Sciences, Strasbourg). Phys. Status Solidi, 9: 753-65(1965). (In French)

Isolated glide planes were obtained in gamma-irradiated LiF crystals which were partially annealed. The birefringence pattern due to stresses was determined by measuring, with a photomultiplier, the transmitted intensities for two different orientations of the nicols. The results are quantitatively interpreted by using dislocation theory and are consistent with Read's theory. (auth)

**32761** THE INFLUENCE OF STRUCTURE ON ATTENUATION AND DELAY OF 4 MHz ULTRASONIC WAVES IN MAGNESIUM ALLOYS MODIFIED WITH ZIRCONIUM. Galanty, A.; Skowronek, S. Prace Inst. Hutneczych, 16: 249-56(1964). (In Polish)

Properties and preparation of Zr-modified Mg alloys of the type MgZr, MgZnZr, MgCeZr, and MgZnCeZr were studied. Effects of microstructure on attenuation were determined. (Rev. Metal Rit., 22: No. 3, (Mar. 1965))

**32762** NEUTRON DIFFRACTION STUDY OF THE LONG RANGE ORDER IN A SINGLE CRYSTAL $Cu_2NiZn$. Hoshino, Sadao (Tokyo Univ.) and Hirabayashi, Makato. Tech. Rept. ISSP, Ser. A, No. 143, [26p.] (Dec. 1964).

It is shown by neutron diffraction that the alloy $Cu_2NiZn$ forms the long range order after prolonged annealing at 300°C. The observed structure factors of the superlattices reflections with mixed indices are evaluated to be between 0.29 and $0.33 \times 10^{-12}$ cm. Three structure models, whose unit cells are based upon the original face-centered-cubic cell containing four atoms, are proposed to interpret the experimental results. A good agreement between the observed and calculated structure factors is found in the following model, i.e., a nickel atom is at the origin, and a zinc and two copper atoms are statistically distributed at the three positions ($\frac{1}{2}$, $\frac{1}{2}$, 0, ○). The possible validity of the other two models is discussed on the basis of the present investigation as well as other physical properties. (auth)

**32763** INTEGRAL DEGREE OF BLACKNESS AND THERMAL CONDUCTIVITY COEFFICIENT OF ZIRCONIUM. Timrot, D. L.; Peletskii, V. E. (Scientific-Research Inst. of High Temperatures, USSR). Teplofiz. Vysokikh Temp., 3: 223-7(Mar.-Apr. 1965). (In Russian)

The improved variant method of electron heating is described. The results of the investigation of the properties of zirconium iodide in the temperature interval from 1200 to 1900°K are reported. (tr-auth)

**32764** THE EFFECT OF URANIUM ON IRON AND STEEL. Hasegawa, Masayoshi; Onoda, Ichiro. Tetsu to Hagane, 4: No. 2, 154-64(June 1964).

Effects of U additions up to 0.7 wt % on low and medium carbon steels and low-alloy steels were determined. In low-carbon steel, U formed the intermetallic compound $Fe_2U$, which decomposed and dissolved in the austenite matrix above 950°C and precipitated at tempering tempera-

tures of about 500°C. Increasing the C content in steel led to the formation of uranium carbide. It was very stable and insoluble even in the austenite matrix at 1200°C. High-tension steel such as the Si–Mn series displayed effects similar to ordinary carbon steel, but 0.5% Mo–B steel (low-carbon bainitic steel) increased in hardness when quenched or normalized at 1150°C and the level of secondary hardening rose in subsequent tempering. (Rev. Metal Lit., 22: No. 3, (Mar. 1965))

**32765** INVESTIGATIONS OF THE DENSITY OF STATES AND THE CHARACTERISTIC ENERGY LOSSES OF Ir, Rh, Pt, AND Pd WITH ISOCHROMATIC MEASUREMENTS. Claus, Helmut; Ulmer, Kurt (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 185: 139-54 (1965). (In German)

X-ray isochromats of the metals measured with high resolution are presented. Assuming a rigid band model for the four metals they give, with some usual approximations, the qualitative form of the density of states. It turns out that the densities of states $Z(\epsilon)$ at the Fermi limits decrease in the succession Ir, Rh, Pt, and Pd. This is in contradiction to low-temperature measurements of the electronic specific heat $c_e$ which for the same succession give an appreciable raising in $Z(\epsilon)$. It is assumed that this discrepancy is caused by a special coupling of the electrons to the transverse phonons. In consequence of this, $Z(\epsilon)$ of the renormalized electron system measured by $c_e$ can be very different from that of the bare electrons measured by the isochromats. Assuming that the transition temperature of elemental superconductors is related according to BCS theory to the latter density of states, the absence of superconductivity of Rh, Pt and Pd can be understood. In addition, the isochromats give values for the characteristic energy losses of the four metals. (auth)

**32766** POSITIVE SURFACE IONIZATION OF POTASSIUM ON TEXTURIZED RIBBONS OF PLATINUM. Chaikovskii, E. F.; Ptitsyn, G. V. (All-Union Scientific Research Inst. of Single Crystals, USSR). Zh. Tekhn. Fiz., 35: 528-34(Mar. 1965). (In Russian)

An experimental investigation was made to clarify the causes of discrepancies in investigations on the positive surface ionization of alkali metals on Pt. Potassium was selected because the Datza and Taylor data on that element deviated considerably from the solutions of the Saha and Langmuir equation. The surface of rolled and heat-treated texturized platinum ribbons was a mosaic of the (111) faces of Pt crystals. Platinum plates were used as emitter and collector. The vapor method of measurement was employed. The experiment established the dependence of ion current on emitter temperature at various magnitudes of potassium vapor pressure, which was varied within a wide range yielding ion current densities from 30 $\mu$amp/cm$^2$ to 80 mamp/cm$^2$. The hysteresis in the dependence of current on temperature, pronounced at lower vapor pressures, diminished as the pressure increased, and disappeared completely at a certain critical pressure. The desorption heat of $K^+$ ions from Pt was 2.5 ± 0.2 ev. The ionization coefficient of K atoms at 1600K° was found to be 90 ± 5%, with the corresponding work function value of 4.8 ± 0.2, somewhat lower than the 5.3 ev derived from Richardson curves for polycrystalline platinum. The difference may be due to the use of a texturized surface in the experiment. The cause for the substantially higher (25%) value of the ionization coefficient as compared to that obtained by Datza and Taylor is ascribed to atomization of the collector and the deposition of its material on the emitter. It was established experimentally that up to 400 monolayers per second may be deposited. The deposits retained their texture of (111) faces. The ionization coefficient dropped considerably when different materials were used for the collector and emitter. The low value of the ionization coefficient obtained in earlier experiments might be explained by the deposition of atomized foreign material on the emitter. (ATD)

**32767** INFLUENCE OF AN ELECTRIC FIELD ON SURFACE IONIZATION ON METALLIC SURFACES. Dobretsov, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 535-8(Mar. 1965). (In Russian)

The influence of an electric field on the surface ionization coefficient was calculated previously (Zh. Tekhn. Fiz. 23,417, 1953), taking into account the influence of the field both on the energy of the electron in the atom and on the evaporation energy of the ion from the surface. The original calculation contains error arising from an incorrect application of an argument involving a cyclic process. This error is corrected, repeating the calculation and obtaining slightly different results than before. (M.J.T.)

**32768** EMISSION OF POSITIVE AND NEGATIVE MOLECULAR IONS FROM HEATED SURFACES. Bakulina, I. N.; Zandberg, E. Ya.; Ionov, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 562-7(Mar. 1965). (In Russian)

A study was made of the thermionic emission of negative ions from surfaces of W, Mo, and Ta in a wide temperature range and of the thermionic emission of positive ions from clean W surfaces at high temperatures. The ion spectra were studied at residual pressure of $10^{-6}$ to $10^{-7}$ torr. Negative ions of several organic compounds were observed and the temperature dependence of their currents was traced. The formation of negative ions of the higher oxides of Mo, W, and Ta was observed. Thermoemission spectra of positive ions from clean W surfaces were taken. The temperature dependences of the positive-ion current for a series of organic compounds were studied. The effect of processes of molecular dissociation on surfaces on the temperature dependence of the surface-ionization currents of molecules and radicals was considered. The upper limits of possible values of ionization potentials of several organic compounds and also the lower limit for WO were determined. (tr-auth)

**32769** PREPARATION OF A URANIUM–ZINC INTERMETALLIC COMPOUND. (to Dow Chemical Co.). British Patent 994,122. June 2, 1965. Filed Oct. 4, 1963.

A process is described for producing a U–Zn intermetallic compound from uranium oxide by reducing the oxide with excess Mg in an inert atmosphere. At least three parts by weight of Zn per weight of residual Mg after reducing U are provided, and the temperature of the reaction mixture is maintained at a temperature of 450–500°C for a time sufficient to allow the MgO to rise to the surface of the melt and the U–Zn intermetallic compound to precipitate for removal at the bottom. The starting reaction mixture contains an excess of Mg, preferably 110% of stoichiometric amount, over that necessary to just reduce the uranium oxide and from 5 to 50 parts by weight of Zn per weight of U. (B.L.M.)

**32770** IMPROVEMENTS IN OR RELATING TO ZIRCONIUM ALLOYS. Child, Henry Cave; Dalton, Alan Leslie (to Birmingham Small Arms Co. Ltd.). British Patent 994,352. June 2, 1965. Filed June 7, 1960.

A group of Zr–base alloys that have good resistance to scaling at elevated temperatures of about 600°C are described. The Zr is alloyed with one or more of the following elements in the following weight percentages: Cu, 0.5–5%; Mo, 1–5%; Fe, 0.5–1.75%; Ni, 0.75–5%; Ba, 0.5-5%. (B.L.M.)

**32771** URANIUM–NIOBIUM–ALUMINUM TERNARY ALLOY. Layne, Gilbert S.; Huml, James O.; Smith, Richard D. (to Dow Chemical Co.). U.S. Patent 3,183,079. May 11, 1965. Filed June 26, 1963.

A ternary intermetallic compound of U, Nb, and Al suitable for use as a reactor fuel element composition is described. The alloy is chemically less reactive than Al and has a melting point of above 800°C. On a weight basis the composition of the alloy is 24% U, 18.8% Nb, and 57.2% Al and the ternary compound corresponds to the formula $UNb_2Al_{21}$. (B.L.M.)

**32772** URANIUM–GALLIUM ALLOYS AND METHOD OF PREPARATION. Wilkinson, Walter D.; Kelman, LeRoy R. (to U. S. Atomic Energy Commission). U. S. Patent 3,193,380. July 6, 1965.

A process is described for preparing a stable suspension of uranium in gallium by heating a mixture of gallium and uranium or uranium hydride (in the latter case at reduced pressure to obtain hydride decomposition) at between 350 and 800°C, whereby a solid uranium–gallium compound is formed and suspended in excessive gallium. The suspensions of $UGa_2$ and $UGa_3$ in gallium are also claimed. (AEC)

## Radiation Effects

**See also CHEMISTRY — Radiation Chemistry.**

*Refer also to abstracts 32551, 32693, 32830, 33513, and 33603.*

**32773** (AD-611145) SINGLE PHONON ABSORPTION BANDS IN FAST-NEUTRON-IRRADIATED SILICON. Technical Note No. 2. Balkanski, M.; Nazarewicz, W. (Paris Univ. (France). Laboratoire de Physique). Sept. 15, 1963. Contract AF62(052)-572. 18p. (AFOSR-5430). $1.00(CFSTI).

Theoretical considerations on the photon phonon interaction and experimental results concerning fast neutron irradiated silicon are presented. The infrared absorption spectrum contains absorption bands at 488, 417, 332, and presumably at 140/cm attributed to a single phonon absorption process connected with the excitation of the fundamental modes, TO, LO, LA, and TA, respectively. These fundamental modes become active because of the lattice polarization bombardment. (auth)

**32774** (AE-186) AN ELECTRON MICROSCOPE STUDY OF THE THERMAL-NEUTRON-INDUCED LOSS IN HIGH-TEMPERATURE TENSILE DUCTILITY OF Nb STABILIZED AUSTENITIC STEELS. Roy, R. B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1965. 16p. Dep.(mn).

Thermal neutron irradiated and the corresponding unirradiated control tensile specimens of a 20% Cr, 25% Ni, Nb stabilized steel tested at 650, 750, and 800°C were examined by transmission electron microscopy. The results indicate that the irradiation induced embrittlement of the tensile specimens at elevated temperatures is preceded by the formation of fine precipitates within the grains. These precipitates may restrict the deformation within the grains such that the stresses are concentrated at the grain boundaries thereby leading to premature failure. It is suggested that the main effect of the irradiation is to promote conditions necessary for the formation of these precipitates, namely, supersaturation and fresh nucleation sites within the matrix through the energetic emission of He and Li atoms from B as an impurity. (auth)

**32775** (AFAPL-TR-65-9) RADIATION ACTIVATION OF PARA-ORTHO HYDROGEN CATALYSTS. Leffler, Amos J. (Little (Arthur D.) Inc., Cambridge, Mass.). Jan. 1965. Contract AF33(615)-1362. 73p.

An investigation was carried out of radiation effects on para-ortho H catalysts. The effects of preparation and neutron radiation on the activity of Fe, Cr, and Ni oxides deposited on boric acid or sodium tetraborate sublayer all on an alumina carrier was studied at 77°K. In most cases, catalytic activity increased temporarily, but decayed rapidly toward the activity of the unreacted material. The possibility of reactivating catalysts in situ was investigated It was determined that neither the introduction of alpha emitters into the catalyst chamber nor the use of ultrasonic energy is an effective reactivation method. (J.R.D.)

**32776** (BNWL-96) BORONATED-GRAPHITE IRRADIATION STUDIES. FINAL REPORT OF IRRADIATION EXPERIMENTS CONDUCTED IN A HANFORD REACTOR. Davidson, J. M.; Gates, L. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1965. Contract AT(45-1)-1830. 43p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Selected physical properties of boronated graphite were measured as a function of the thermal neutron exposure. The samples were prepared by adding 5 and 7 wt % $B_4C$ to petroleum-coke, pitch-binder mix. Two types of samples were obtained for each wt % $B_4C$; one with $B_4C$ particles dispersed in the graphite matrix, and one in which extensive recrystallization had occurred allowing the B to become uniformly dispersed. The latter material experienced the greater radiation damage and had length changes up to 3%. Compressive strengths were increased and thermal conductivities were decreased for all materials. No generalized fracturing was observed. (W.L.G.)

**32777** (ORNL-3504) IRRADIATION EFFECTS IN THE EGCR FUEL. Baumann, C. D. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 191p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

Two types of experiments were carried out to develop the fuel elements for the initial loading of the EGCR. A series of 16 prototype elements were tested in the ORR and 22 miniature fuel capsules were irradiated in the Low-Intensity Test Reactor (LITR). The prototype elements were similar to the proposed EGCR elements except that (1) the ends of the pellets were not dished; (2) the length was two-ninths that of the proposed element; and (3) in some cases, pellet geometry differed. The purpose of these experiments was to proof-test the proposed EGCR elements and, to investigate pellet-geometry effects. The miniature fuel capsule experiments were designed primarily to investigate the dependence of fission-gas release on fuel characteristics and operating conditions. In the prototype experiments it was found that (1) no significant amount of fuel migration or shifting occurred in hollow, uncored pellet test elements even though the pellets were friable after irradiation; (2) ratcheting occurred; (3) ridges formed on the cladding opposite pellet interfaces when the cladding was at 1500°F or above, and sigma phase and small voids were found in the neighborhood of the ridges; (4) no significant $UO_2$-cladding or fill-gas–cladding interactions occurred except for cladding nitriding when the fuel contained large amounts of nitrides; and (5) the fission-gas release was not relatively temperature sensitive. The miniature fuel experiments showed that fission-gas release (1) increased for burnups above about 15,000 Mwd per metric ton of $UO_2$; (2) increased as burnup rate increased; (3) was sensitive to fuel structure; (4) dependence on O/U ratio was confused by density effects; and (5) diffusion constants for Xe and Kr were about the same. (auth)

**32778** (SC-DC-65-1421) THE USE OF LASERS TO SIMULATE RADIATION-INDUCED TRANSIENTS IN SEMICONDUCTOR DEVICES AND CIRCUITS. Habing, Donald H. (Sandia Corp., Albuquerque, N. Mex.). [May 1965]. Contract AT(29-1)-789. 37p. (CONF-650707-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IEEE Annual Conference on Nuclear and Space Radiation Effects, Ann Arbor, Mich.

It is shown that an i-r laser produces ionization sufficiently intense and well-distributed in semiconductors to justify the use of the laser in the simulation of effects of transient ionizing radiation on semiconductor components and circuits. The advantages and drawbacks of the laser technique are outlined. (T.F.H.)

**32779** GAMMA-RAY INDUCED CONDUCTIVITY IN INSULATING POLYMERS. Furuta, Junichiro; Hiraoka, Eiichi (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 80-4(Mar. 1965).

The gamma-ray induced currents in various linear polymers and their decay currents were measured at room temperature with fixed dose rates of irradiation. The samples used were polyethylene, teflon, polypropylene, polystyrene, polymethylmethacrylate, polyvinylchloride, and trifluorochloroethylene. Polyethylene and teflon showed maximum values of induced currents and the others showed monotonous slow increase during the irradiation. On stopping of irradiation, fast initial decay was observed, and the decay currents were divided into several currents having different decay time constants. These time constants were intrinsic for various polymers. (auth)

**32780** ANISOTROPIC EFFECTS OF PROTON AND ELECTRON IRRADIATION ON THE DEFORMATION OF

MONOCRYSTALLINE ZINC. Troitskii, O. A. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Fiz. Metal. i Metalloved., 19: 443-6(Mar. 1965). (In Russian)

New data are presented on the effects of oriented protons and electron irradiation on deformation of Zn monocrystals in plastic and forced brittle states. (tr-auth)

**32781** DISLOCATION LOOPS IN IRRADIATED IRON. Masters, B. C. (Central Electricity Generating Board, Berkeley, Glos., Eng.). Phil. Mag. (8), 11: 881-93(May 1965).

Dislocation loops were observed in iron foils irradiated with protons or $Fe^+$ ions of energy 150 kev. Those produced by irradiation with $Fe^+$ ions are shown to lie on {100} planes and to be pure edge in character. They are normally square, with the sides in the corresponding ⟨100⟩ directions, and are formed by the condensation of interstitial atoms. It is believed that the loops are formed because of the excess concentration of interstitial atoms resulting from the direction insertion of atoms on bombardment. It is shown that either a homogeneous or a heterogeneous nucleation mechanism can account for the loop density observed. Finally, an estimate is made of the strain energy of various modes of condensation of point defects in iron. The most favored are $\frac{1}{2}$[111] (110), $\frac{1}{2}$[111] (111), and [100] (100). (auth)

**32782** THE MECHANISMS OF IRRADIATION CREEP IN GRAPHITE. Hesketh, R. V. (Central Electricity Generating Board, Berkeley, Glos., Eng.). Phil. Mag. (8), 11: 917-27(May 1965).

The motion of edge and screw dislocations in a graphite polycrystal subjected to external forces and fast neutron irradiation is considered. A transient creep strain, proportional to the external stress and proportional to the ratio of the dimensions of the component crystallites in the a and c directions, is deduced. The calculated and experimentally observed magnitudes agree. From the time constant of this transient a value for the number of defect pairs created by a neutron during its moderation is calculated. There is fair agreement with accepted estimates. Graphite crystals show irradiation growth and a polycrystal must therefore either disintegrate or show yielding creep. The equations of yielding creep predict a creep rate greater than that observed, but they do not take into account that graphite is not a continuous solid. The discrepancy may thus be resolved. The possibility of an increase in the number of modes of deformation during neutron irradiation is discussed. (auth)

**32783** IRRADIATION CREEP IN GRAPHITE AT 40°C. Hesketh, R. V. (Central Electricity Generating Board, Berkeley, Glos., Eng.). Phil. Mag. (8), 11: 929-35(May 1965).

Restrained growth assemblies of P.G.A. graphite were irradiated at 40°C to a neutron dose of $10^{20}$ $cm^{-2}$ (nickel). Differential growth strains, final Young's Moduli and post irradiation fracture stresses were measured. Two tensile specimens fractured during irradiation. In those recovered intact the final elastic strain was measured. The tensile strain to fracture during this irradiation is five to six times the unirradiated value. On the assumption that the transient creep is proportional to stress and independent of temperature, the continuous creep rate is between three and six times that at 250°C. Comparison with several predictions is made. (auth)

**32784** RECOVERY OF ELECTRICAL ANISOTROPY IN HIGHLY ORIENTED PYROCARBON AFTER NEUTRON IRRADIATION AT −195°C. Pieragostini, F.; Domenici, M.; Perito, U.; Walther, H. (SORIN, Saluggia, Italy). Phys. Letters, 17: 25-6(June 15, 1965).

Isochronal recovery of electric resistivity was studied for directions both parallel and perpendicular to the deposition plane. A combination of the two parameters gives the recovery of electrical anisotropy $\rho c/\rho a$. From the experimental results it is concluded that the defects produced by irradiation increase electric resistivity in the direction parallel to the deposition plane and decrease the same in the perpendicular one. The same recovery mechanism which increases electric resistivity in the direction parallel to the deposition plane decreases the same in the perpendicular one. Qualitative agreement is found between present results and those on structural anisotropy. Since radiation damage drastically reduces electrical anisotropy it is considered a very sensitive parameter for fundamental studies, including radiation damage and structural research. (J.F.P.)

# METEOROLOGY

*See also* GEOLOGY AND MINERALOGY — Site Survey and Selection.

**32785** (AECL-2232) EXCHANGE RATES OF RADIOACTIVE TRACERS BETWEEN THE ATMOSPHERE AND SNOW. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 13p. Dep.; $0.50(AECL).

A new model of heat and mass exchange between air and natural surfaces is developed in which molecular and pressure forces work in parallel. Field experiments were conducted on snow and wind using tritiated water vapor and radioiodine. The results show a simple correlation between the form drag coefficient and the Reynolds number: $C_F = 1.5 \times 10^{-3} (uZ_0/\nu)^{0.35}$. This correlation is valid over a wide range of Reynold's numbers from 0.03 to 30, covering both smooth and fully rough flow. (D.L.C.)

# PHYSICS

## General

*Refer also to abstracts 32048, 32416, and 32502.*

**32786** (AD-610054) NUCLEAR WEAPONS EFFECTS. Comprehensive Report. (Aerospace Technology Div., Library of Congress, Washington, D. C.). Jan. 14, 1965. 24p. (TT-65-60769; ATD-P-65-1). $1.00(CFSTI).

The report on Soviet open sources from 1955 to August 1964 consists of three sections. The first section deals briefly with the structure and parameters of strong shock waves in solids and in gases. The second section presents a study of the propagation of strong shock waves in compressible media, collisions of such waves at high velocities, and the explosions associated with collisions at such velocities. The last section, entitled Meteorite Analogy, consists of material believed to be of significance in that it reflects Soviet interest in the study of meteorites as a means of simulating the effects of high-power explosions, especially nuclear explosions. The last section also covers one particular case of meteoritic collision, namely the explosion of the Tunguska meteorite/comet of 1908. (CFSTI)

**32787** (NIRS-3(p.1-17)) PHYSICAL SCIENCES. Physics; Chemistry. (National Inst. of Radiological Sciences, Chiba (Japan)).

Physics research is reported on: neutron capture cross sections near 30 kev using a Moxon-Rae Detector; neutron flux distributions in water phantoms and tissue equivalent material; thermoluminescence of powdered and polished potassium bromide; shielding of high energy electrons and x rays; energy distribution of electrons ejected from bone and lucite by 150–300 kvp x rays; dosimetry of high-energy x rays and electrons; a logarithmic converter for nuclear pulses; the statistical nature of low background counters; beta-spectroscopy of low level samples by a coincidence type scintillation spectrometer; a low background beta-spectrometer using a double-layer scintillator; and measurement of radioactivity in man by whole body counters. Studies reported in chemistry are: collisional deactivation of the excited states of oxygen atoms; a rapid separation of iodine anions by thin layer chromatography; visible and infrared absorption spectra of copper glycylglycinate; and concentration of radionuclides in sea water by ferric hydroxide type resin. (H.G.D.)

**32788** (FTD-TT-65-27) ON THE SEPARATION OF A MAGNETOHYDRODYNAMIC BOUNDARY LAYER. Tsinober, A.; Shtern, A.; Shcherbinin, E. Translated from Latvijas PSR Zinatnu Akad. Vestis, No. 12, 49-56(1963). 13p. CFSTI.

An attempt is made to experimentally and theoretically consider the question of the effect of a transverse magnetic field on the position of the separation point of a laminar boundary layer. The results of experiments to determine such an effect are presented, and a solution of the problem of the effect of a magnetic field on the development of a boundary layer is given. The question of the possibility of approximating the conditions of the experiment is posed. (auth)

**32789** ANOMALOUS TRANSMITTIVITY IN DYNAMICAL X-RAY INTERFERENCE THEORY. Zielinska-Rohozinska, E. (Univ. of Warsaw). Acta Phys. Polon., 27: 587-94(Apr. 1965).

The intensity distribution is found and analyzed on the basis of dynamical x-ray interference theory for the Laue and Bragg cases when $\chi_{hr}$ and $\chi_{hi}$ are of the same order and $\chi_h \neq \chi_{\bar{h}}$. (auth)

**32790** NOTE ON THE INEQUIVALENCE OF CLASSICAL AND QUANTUM HAMILTONIANS. Kennedy, Frederick J. Jr.; Kerner, Edward H. (Univ. of Delaware, Newark). Am. J. Phys., 33: 463-6(June 1965).

By working directly from Newtonian equations of motion and representing acceleration x as [(x,H),H], families of hamiltonians may be constructed which are functions of the energy and which, while describing the same classical motions, are not connected by canonical transformations. One-dimensional examples are given, and the formal rules of quantization executed when H is (energy)$^{\frac{1}{2}}$ to show that the quantum motion does not come out right. The reason is that the commutation rule (x,p) = ih does not have universal standing; quantum theory in employing this rule is apparently requiring not merely that H be a generator of motion, but also that it be a very particular one, viz., the energy when the system is conservative. (auth)

**32791** A CALCULATION OF THE ELECTRIC ELEMENTARY CHARGE OR THE SOMMERFELD FINE STRUCTURE CONSTANT. Zuhrt, Harry. Arch. Elek. Uebertrag., 18: 121-8(Feb. 1964). (In German)

With the aid of a model of the energy quanta developed previously as an extended version of Einstein's light quantum model, which takes account in model form of the carriers of the electromagnetic field as well as of the mass particles and thus of the electron, the energy picked up by an electron in an electrostatic field is calculated; and from this, by comparison with the well-known formulas, the elementary electrical charge and Sommerfeld's fine structure constant are obtained. The elemenatry electrical charge is found from a definite integral with an error of 0.21%, which can be explained by the approximations introduced in the numerical calculation. The numerical values obtained in a previous paper are corrected. (auth)

**32792** ON THE DISTRIBUTION OF ZEROS OF THE GRAND PARTITION FUNCTION. SOME EXACT RESULTS. Hemmer, P. C.; Hauge, E. Hiis; Aasen, J. O. (Norges Tekniske Hogskole, Trondheim, Norway). Arkiv Fys. Seminar Trondheim, No. 4, 15p.(1965).

An investigation of the relation between the zeros of the polynomial $Z_g$ and its coefficients which are complicated integrals involving the intermolecular potential $\phi(r)$ is included. A distribution consistent with the equation of state is determined. Also presented is a direct calculation of the roots of the grand partition function. The zeros are found to be distributed on the negative real axis. (M.O.W.)

**32793** ON THE RELATIVISTIC FORMS OF BOLTZMANN EQUATION. Abonyi, Ivan (Roland Eotvos Univ., Budapest). Beitr. Plasmaphysik, 5: 1-8(1965).

The relativistic forms of the collision-free Boltzmann equation as proposed by Taub, Clemmow and Willson, Linhart, and Ken-iti Goto are investigated from the point of view of their mutual relation. It is shown that the most exact forms, given by Taub, Clemmow and Willson, and Linhart, are completely equivalent, while Ken-iti Goto's version is restricted to the case of four-power-free forces. (auth)

**32794** CONDUCTIVITY OF DUST-LADEN GASES. Sodha, M. S.; Kaw, P. K.; Srivastava, H. K. (Indian Inst. of Tech., New Delhi, India). Brit. J. Appl. Phys., 16: 721-3(May 1965).

An analysis is made of electron density and collision frequency in gases containing thermionically emitting dust suspensions. Two graphs are presented which permit the calculation of electric conductivity over a wide range of conditions appropriate to magnetohydrodynamic generation of power. (auth)

**32795** ON THE KELVIN-HELMHOLTZ PROBLEM IN MAGNETOHYDRODYNAMICS WITH FINITE CONDUCTIVITY. Wentzell, R. A. (Univ. of Western Ontario, London). Can. J. Phys., 43: 1342-6(July 1965).

A study was made of the effect of large but finite conductivity upon Kelvin–Helmholtz-type instabilities in the presence of a horizontal magnetic field. For finite conductivity,

the selected Kelvin–Helmholtz-type problem which is stable at infinite conductivity is stable no matter how large the magnetic field. These instabilities grow aperiodically at a rate proportional to (resistivity). (auth)

**32796** THEOREMS OF THE EXISTENCE OF UNICITY FOR A RELATIVISTIC THERMODYNAMIC FLUID. Lichnerowicz, Andre (Universite, Paris). Compt. Rend., 260: 3291-5(Mar. 22, 1965). (In French)

The theorems of existence and of uniqueness of the Cauchy problem established by Choquet-Bruhat (Bull. Soc. Math. Fr. 86: 155(1958)) are extended to a thermodynamic relativistic fluid in the Taub sense. The case of a charged fluid with zero conductivity is considered. (tr-auth)

**32797** DISPERSION RELATIONS IN CLASSICAL PHYSICS. Attila, Janos Horvath (Jozsef Univ., Szeged). Fiz. Szemle, 15: 7-16(Jan. 1965). (In Hungarian)

The development of the Kramers-Kronig theory is outlined on the basis of classical relations attempting to clarify the modern physical applications of the dispersion concept. It is shown that dispersion relations lead directly to the concept of causality conditions; this is examined in connection with the reversibility or irreversibility of the phenomena considered on the basis of conservation of energy. The action-at-distance concept is eliminated, assuming that interactions always refer to local interactions. The phenomenologically derived correlations may be very useful in the linear network theory, optics, statistical mechanics, elementary particle physics, regardless of whether the classical electron theory or quantum mechanics served as the general framework. The dispersion relations became the subject of general interest when Kronig pointed out that in the quantum mechanical dispersion theory, determination of the analytical properties of the S matrix reveals important correlations between the energy, mass, pulse and other parameters of the colliding particles; many of these correlations cannot be explained by the classical theoretical methods. (TTT)

**32798** DETERMINATION OF THE EMISSIVITY OF NIOBIUM AS A FUNCTION OF THE ROUGHNESS OF THE SURFACE. Gordon, A. R.; Muchnik, G. F. High Temp. (USSR) (English Transl.), 2: 505-8(July-Aug. 1964). Translated from Tepolfiz. Vysokikh Temp., 2: 562-4 (July-Aug. 1964).

The emissivity of niobium was determined in the range from 1200 to 2000°K for five different classes of surface finish. The high accuracy of the experiments made it possible to distinguish between the emissivities of samples differing in treatment by only one subclass (division). For a polished surface, good agreement with other data was obtained. (auth)

**32799** COLLISION INTEGRALS FOR ELECTRONS WITH HYDROGEN ATOMS. Dubner, V. M. (High Temperatures Research Inst., USSR). High Temp. (USSR) (English Transl.), 2: 584-9(July-Aug. 1964. Translated from Tepolfiz. Vysokikh Temp., 2: 648-50(July-Aug. 1964).

Collision integrals for electrons and hydrogen atoms at temperatures below 15,000°K were calculated using effective cross sections obtained from the phase shifts calculated by Temkin and Lamkin by the method of polarized orbitals. Numerical results are included. (D.C.W.)

**32800** SPATIALLY INHOMOGENEOUS STATES OF MANY-BODY SYSTEMS. Eger, M.; Gross, E. P. (Brandeis Univ., Waltham Mass.). J. Math. Phys. (N. Y.), 6: 891-901(June 1965).

To treat many-body systems in the presence of a static potential or problems of highly collective spatially inhomogeneous motions such as vortex lines, wavefunctions of a type $\Psi = \Pi_{i=1}^{N} g(x_i)\Phi(x_1, \ldots, X_N)$ were proposed. Here $\Phi$ is the exact ground state of the homogeneous system and g(x) is a one-particle state introduced to describe the effect of the spatial inhomogeneity. However, to determine g(x) by the variation principle, one needs to know the spatial correlation functions of all orders for the homogeneous many-body system. It is shown that the method of point transformations allows one to work with qualitatively similar but different states. The description of the system in the presence of a static impurity or of a state representing a vortex line in liquid helium requires a knowledge of only the average kinetic energy and x-ray scattering factor for homogeneous liquid helium. Both of these are available from experiments. The treatment of a recoiling impurity atom, strictly speaking, requires a knowledge of the current correlation tensor for the ground state of the homogeneous many-body system. This term vanishes in the Hartree limit of the theory for bosons. (auth)

**32801** GENERALIZED BOLTZMANN EQUATION FOR A QUANTUM GAS OBEYING CLASSICAL STATISTICS. Fujita, S. (Pennsylvania State Univ., University Park). J. Math. Phys. (N. Y.), 6: 1004-8(June 1965).

By means of the connected-diagram expansion a generalized Boltzmann equation is obtained for the Wigner distribution function f describing distinguishable quantum particles subject to constant electric and magnetic fields. This equation is exact and meaningful in the thermodynamic limit provided that the main interaction processes which cause the change in f involve finite numbers of particles. If the interaction processes are assumed to be localized in time, and long-time solutions are looked for, the equation could be simplified so that its collision term can be described in terms of f only just like the conventional Boltzmann equation for a dilute gas. (auth)

**32802** FLUCTUATIONS IN EQUILIBRIUM AND NON-EQUILIBRIUM ENSEMBLES. Jones, Gerald L.; Davies, Michael (Univ. of Notre Dame, Ind.). J. Math. Phys. (N. Y.), 6: 1009-14(June 1965). (COO-427-40).

Using the results of a previous paper, the probability of a fluctuation occurring in a given time interval, of certain dynamical variables, is considered for a rather general nonequilibrium situation and also a more specialized equilibrium case. In the first case it is shown that this probability vanishes at least as fast as 1/N. In the second case a much stronger decrease of the probability with increasing N is obtained. (auth)

**32803** GENERAL THEORY OF SIMPLE WAVES IN ONE-DIMENSIONAL MAGNETOHYDRODYNAMICS. Gundersen, Roy M. (Univ. of Wisconsin, Milwaukee). J. Mecan., 4: 3-19(Mar. 1965). (In French)

Equations governing the one-dimensional, unsteady flow of an ideal, inviscid, perfectly conducting compressible fluid with general magnetic and velocity vectors are written in characteristic form. Solutions are found and extended to the general case and in a form which includes previous results as special cases. It is shown that the general solution for the nonisentropic perturbation of an arbitrary (non-centered) simple wave may be obtained by quadratures. The solution includes the perturbation of a centered simple wave as a special case. (M.O.W.)

**32804** LOW-VOLTAGE ARC IN CESIUM VAPOUR. Yavor, I. P. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Letters, 16: 127-8(May 15, 1965).

The preliminary results of an experimental investigation of the low-voltage arc in cesium vapor are reported. The arc was maintained between a plane emitter and a plane collector made of tungsten set at a distance of 1.6 mm from one another. The electron excitation temperature $T_e$ was determined from the relative intensities of a number of cesium spectral lines, and the electron concentration $n_e$ was determined by the broadening of the lines of the Cs fundamental series caused by the quadratic Stark effect. The variation of $T_e$, $n_e$, and intensity of the 5839 Å line with the distance from the emitter to the cathode is shown. The linear dependence of the spectral line intensity on $n_e$ suggests that other than one-step processes do not contribute significantly to excitation and ionization. (L.B.S.)

**32805** EQUATION OF STATE OF $^4$He IN THE CRITICAL REGION. Tisza, Laszlo; Chase, C. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 15: 4-6(July 5, 1965).

Measurements taken by Edwards and Woodbury (Phys. Rev. 129, 1911 (1963)) who determined the orthobaric

densities of $^4$He to within 36 Mdeg of $T_c$ for the liquid and 50 Mdeg for the vapor are analyzed. These results are integrated with the formalism of thermodynamics. (M.O.W.)

**32806** APPLICATION OF THE QUANTUM THEORY OF CORRESPONDING STATES TO THE PROBLEM OF CRITICAL-POINT EXPONENTS. Sherman, R. H.; Hammel, E. F. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 15: 9-11(July 5, 1965).

Previous suggestions that the behavior of lighter gases in the vicinity of their critical points should be influenced by quantum mechanical diffraction effects are considered. It is suggested that these effects can be treated systematically by a theory of corresponding states, which was developed previously. (M.O.W.)

**32807** A HOLLOW LARGE-DIAMETER CATHODE WITH A UNIFORM DISCHARGE. Klement'ev, V. M. (Inst. of Radiophysics and Electronics, Academy of Sciences, Siberian SSR). Pribory i Tekhn. Eksperim., No. 2, 30-3 (Mar.-Apr. 1965). (In Russian)

Large-diameter cylindrical hollow cathodes with uniform discharge were investigated experimentally. The uniform discharge was obtained with introduction in the discharge space of grids of high transparency. In such cathodes uniform plasma layers could be obtained on the metallic surface for investigation of its properties. (tr-auth)

**32808** BOUNDARY CONDITIONS FOR ONE-DIMENSIONAL EQUATIONS OF KINETIC MOMENTS. Maev, S. A. Teplofiz. Vysokikh Temp., 3: 207-15(Mar.-Apr. 1965). (In Russian)

Boundary conditions for one-dimensional transfer equations for mixtures of neutral and charged particles in the 20-moment approximation were obtained by the Grad method. In the diffusion approximation boundary conditions were recorded in the form convenient for calculation of the thermoelectron transformer energy. (tr-auth)

**32809** PARTICLE IONIZATION EQUILIBRIUM CONSTANT. Samuilov, E. V. (Krizhizhanovskii Inst. of Power Engineering, USSR). Teplofiz. Vysokikh Temp., 3: 216-22(Mar.-Apr. 1965). (In Russian)

The equilibrium constants of thermal and photo ionization of particles of any radius were obtained with calculation of the screening effects of the electron-ion cloud, surrounding the particles. The effects of the surface properties of the particles were also calculated for the case of complete and incomplete thermodynamic equilibrium. The limits of the applicability of the terms obtained are indicated. (tr-auth)

**32810** ON THE SECONDARY EXTINCTION OF X-RAYS. Chen, Chi. Wu Li Hsueh Pao, 21: 665-73(Mar. 1965). (In Chinese)

A more rigorous treatment of secondary extinction is presented, taking into account the change in the state of polarization of multiply diffracted x rays in mosaic crystals. Separate expressions for the transmitted and multiply diffracted power are obtained with which the effective absorption coefficient is calculated. (D.C.W.)

**32811** WALL EFFECTS IN NUCLEAR MAGNETIC RELAXATION IN FLUIDS. Michel, D.; Pfeifer, H. (Universitat, Leipzig). Z. Naturforsch., 20a: 220-6(Feb. 1965). (In German)

The shortening of the nuclear magnetic relaxation times of liquid molecules on solid surfaces as a result of the movement inhibition or an interaction with paramagnetic centers leads in macroscopic probes to a dependence of the resulting relaxation times on the surface-volume ratio since a certain exchange continually occurs between the interior of the probe and the wall zone. It was found that the known two-phase formula, applied to the free liquid–monomolecular wall layer system, overestimates the wall effect; the smaller the surface–volume ratio, the larger the overestimation. The application of a corresponding corrected formula runs into difficulties, however, since experience has shown that the actual surface, because of the existence of micropores, is a multiple greater than the known geometric surface (in the glass used by a factor of 20). The treatment of the problem by solution of the diffusion equation with the boundary condition that the magnetization at the wall always has the equilibrium value leads in not-too-large surface-volume ratios to a quantitative agreement with experiment, although this boundary condition is equivalent to the requirement $\tau_W \gg T_{1W}$, which is in opposition to the experimentally proved inequality $\tau_W \ll T_{1W}$ ($\tau_W$ = mean residence time of the liquid molecule at the wall, $T_{1W}$ = appropriate relaxation time). For explanation of this state of affairs, the micropores at the wall were referred to and it was found that the solution of the diffusion equation with the given boundary condition yields, in each case, an upper limit for the size of the wall effect. (tr-auth)

**32812** PROPAGATION OF PHOTONS IN A MEDIUM OF RESONANT MOLECULES. Vdovin, Yu. A.; Galitskii, V. M. (Inst. of Physics Engineering, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1052-65(May 1965). (In Russian)

The lower excited states of a system consisting of strictly resonant two-level molecules and an electromagnetic field are investigated. Operators of elementary excitations (medium quanta) are introduced. Decay of the excitations is investigated, and an adequate diagram technique is developed. The Green function for a photon in such a medium is determined. Propagation of photons in such a molecular system is investigated under the condition that either a photon or a medium quanta are present at the initial moment of time. The processes responsible for photons leaving or entering a given state are taken into account. The energy distribution of the photons is determined. (auth)

**32813** COLD EMISSION OF ELECTRONS FROM THE SURFACE OF A METAL IN A STRONG RADIATION FIELD. Bunkin, F. V.; Fedorov, M. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1341-6(May 1965). (In Russian)

The cold emission electron current from the surface of a metal due to the action of an electromagnetic wave is calculated. In the limiting case of small frequencies and large field strengths, the well-known expression for autoemission of electrons is obtained, while for large frequencies an expression is obtained for the photocurrent due to simultaneous absorption of several photons. Numerical estimates are presented. (auth)

**32814** CHARGE EXCHANGE IN COLLISIONS OF MULTI-CHARGED IONS. Bykhovskii, V. K.; Nikitin, E. E. (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 48: 1499-1507(May 1965). (In Russian)

The probability for charge exchange of multi-charged ions ($A^{+2} + B \rightarrow A^+ + B^+$) is calculated by the theory of nonstationary perturbations in the two-level and classical nuclear motion approximations for the case of coulomb interaction in one of the channels ($A^+ + B^+$). The nondiagonal interaction matrix element in the atomic function representation is approximated by an exponential function of the interatomic distance. The coupled equations for the probability amplitudes are written down in the molecular electron function representation and are integrated numerically in a broad range of variation of the parameters of the problem ($\delta$ and $\gamma$). The limits of applicability of the Landau-Zener formula are determined. (auth)

**32815** RELATIVISTIC MOTION OF CHARGED PARTICLES IN A TWO-DIMENSIONAL ELECTRON-OPTICAL SYSTEM POSSESSING A MEDIAN PLANE. Siladi, M.; Yavor, S. Ya. (Inst. of Technical Physics, Academy of Sciences, Budapest and Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 402-4(Mar. 1965). (In Russian)

A study is made of the motion of a charged particle in a two-dimensional static electromagnetic field possessing a median plane with respect to which the electric field is symmetric and the magnetic field is antisymmetric. The relativistic equations for the trajectory of a particle moving

in the median plane are solved (in terms of a quadrature), and a second order homogeneous linear differential equation is derived for the approximate trajectory of a particle moving nearly in the median plane. The trajectory equations reduce in the nonrelativistic case, and also in the case of a paraxial trajectory, to previously known equations. An equation for vertical focusing previously given is generalized to take account of space-charge effects in the nonrelativistic limit. (ATD)

**32816** ON THE BEHAVIOR OF AN AXIALLY SYMMETRIC FLOW OF A PERFECTLY CONDUCTING GAS NEAR THE VERTEX OF AN ANGLE. Shubin, A. P. Zh. Tekhn. Fiz., 35: 405-9(Mar. 1965). (In Russian)

The isentropic isomagnetic axially symmetric potential flow of a perfectly conducting gas in a channel of the shape obtained by rotating a broken line about an axis is discussed. The flow is considered only in the immediate vicinity of the angle. The azimuthal component of the velocity and all components of the magnetic field except the azimuthal are assumed to vanish. If either the ratio of the specific heats is 2 or the magnetic field is large, the flow is approximated by the usual Prandtl-Meyer flow. The first-order correction terms for the case of strong magnetic field and supersonic flow are obtained by a perturbation method that can also be employed to calculate the higher order terms. The effects of gas viscosity and the infinite current density at the vertex of the angle are discussed briefly, and it is concluded that the solution obtained is applicable to the case of a channel with perfectly conducting walls. (ATD)

**32817** PENETRATION OF A PULSED MAGNETIC FIELD INTO THE INTERIOR OF A CYLINDRICAL SHIELD. Vitkov, M. G. Zh. Tekhn. Fiz., 35: 410-13(Mar. 1965). (In Russian)

The penetration of a varying longitudinal magnetic field into the region enclosed by an infinite thin cylindrical shell of finite electric conductivity and magnetic permeability is studied by the method of Laplace transformations (Heaviside operational calculus). Approximate formulas are derived for the relaxation times, and the time dependence of the internal magnetic field following a sudden change in the value of the constant uniform longitudinal external magnetic field is presented graphically. (ATD)

**32818** INFLUENCE OF THE LAW OF VARIATION OF THE CROSS SECTION AREA OF A ONE-DIMENSIONAL ELECTRON BEAM ON THE MAGNITUDE OF THE BEAM CURRENT. Ryabinkin, Yu. S. Zh. Tekhn. Fiz., 35: 428-30(Mar. 1965). (In Russian)

By a one-dimensional electron beam is understood an electron beam of finite and possibly variable cross section in which the current density, particle density, electric field, and potential depend only on one Cartesian coordinate, the axis of which is parallel to the beam. Space-charge limited one-dimensional electron beams are considered in vacuum, where the electron velocity is proportional to the square root of the potential, and in a solid, where the electron velocity is proportional to the potential gradient. Expressions are sought for the total beam current in terms of the potential drop from anode to cathode and the cross section area as a function of position. Such an expression, involving two quadratures, is found for the case of an electron beam in a solid. The corresponding expression for the beam in vacuum involves an unknown function. For the case of a beam with constant cross section area (but not necessarily constant cross section shape), these expressions reduce to the known square and 3/2 power laws for the beams in a solid and in vacuum, respectively. (ATD)

**32819** INFLUENCE OF THE GEOMETRIC PARAMETERS ON THE OPTICAL PROPERTIES OF A SYSTEM OF FOUR QUADRUPOLE LENSES, ANALOGOUS TO AN AXIALLY SYMMETRIC LENS. Dymnikov, A. D.; Fishkova, T. Ya.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 431-40(Mar. 1965). (In Russian)

A type of quadrupole quadruplet consisting of two identical quadrupole doublets and having properties analogous to those of an axially symmetric lens was previously described. These quadrupole quadruplets are capable of forming a true image and, to compensate for their complexity, have some advantages over axially symmetric lenses, including possibilities for compensation of spherical and chromatic aberrations. Extensive numerical computations of the first order optical properties of these quadruplets as functions of the system parameters were performed. Results of these calculations are presented in graphical form suitable for preliminary design purposes. The system parameters are the lengths of the two quadrupoles of the doublet, the separation between them, the separation between the two doublets, and the excitation of one quadrupole; the excitations of the other quadrupoles are then determined by the condition for axial quasisymmetry. Particular attention is given to conditions for minimum focal length and maximum magnification. (ATD)

**32820** RADIATION FROM THE OPEN END OF A PLANE SEMIINFINITE WAVEGUIDE. Aivazyan, Yu. M.; Sedrakyan, D. M. Zh. Tekhn. Fiz., 35: 459-64(Mar. 1965). (In Russian)

By a plane semi-infinite waveguide is understood a system consisting of two opposed parallel conducting half-planes. The radiation of a point charge moving uniformly in a plane perpendicular to the walls of a semi-infinite plane waveguide is calculated by a variant of the Wiener-Hopf method employing the technique of D. S. Jones (Quart. J. Math. (2) 3: 189(1952)). The trajectory of the particle is assumed not to intersect the walls of the waveguide. Formulas are derived for the radiation field and the power radiated both inside and outside the waveguide. When the separation between the walls of the waveguide approaches zero, the formula derived for the radiated energy approaches that obtained for the case of a charged particle passing a conducting half-plane. (ATD)

**32821** THE Q FACTOR OF A SPHERICAL CAVITY. Kuznetskii, R. S. Zh. Tekhn. Fiz., 35: 465-9(Mar. 1965). (In Russian)

An approximate formula is derived for the Q of a spherical cavity excited in one of its normal modes. The derivation is accomplished by first calculating the field in an ideal cavity with perfectly conducting walls and then calculating the Joule heat due to the current induced by this field in a finitely conducting wall. In calculating the Joule heat it is assumed that the skin depth is small compared with the radius of the cavity. The result of the calculation is $Q = (2\pi\sigma\delta/c)\beta$. Here $\sigma$ is the wall conductivity, $\delta$ is the skin depth, and $\beta$ is a numerical factor depending on the normal mode excited. In the case of a magnetic mode (vanishing radial electric field), $\beta$ is a root of the appropriate spherical Bessel function; in the case of an electric mode, it is a root of a more complicated equation. As an example, it is computed that a spherical copper cavity 1 meter in diameter excited in its first electric mode and for which the skin depth is $4.07 \times 10^{-4}$ cm has a Q of $9.06 \times 10^{8}$. (ATD)

**32822** INTERACTION OF CHARGED PARTICLES WITH A GYROTROPIC FERRITE. Gazazyan, E. D.; Mergelyan, O. S. Zh. Tekhn. Fiz., 35: 539-41(Mar. 1965). (In Russian)

The Cherenkov radiation of a charged particle moving parallel to the external magnetic field in a magnetized ferrite is calculated. The medium is described by the following relation between the electric and magnetic fields E, H and the displacement and induction, D, B: $D = \epsilon E$, $B = \mu H + i[gH]$, where $\epsilon$, $\mu$ are constant scalars and g is a constant vector. The dispersion equation for electromagnetic waves is derived and discussed briefly. An expression for the field of a charged particle moving with constant velocity parallel to g is obtained in the form of an integral over frequency of a rather involved function, and the energy loss per unit path length is calculated. Two waves can be radiated, which are elliptically polarized in opposite senses. When g is small, only a single circularly polarized wave is present at great distances. This case has been previously discussed. When $g = 0$, the formula for the energy loss reduces to that given by I. Ye. Tamm and I. I. Frank (Dokl. Acad. Nauk SSSR 14: 107(1937)). (ATD)

**32823** CHERENKOV RADIATION OF A RING CURRENT IN A BRILLOUIN CLOUD. Lominadze, D. G. (Inst. of Physics, Tiflis, USSR). Zh. Tekhn. Fiz., 35: 568-71(Mar. 1965). (In Russian)

The excitation of an axially symmetric Brillouin electron cloud by an infinitely thin current ring moving with uniform velocity perpendicular to its plane and parallel to the magnetic field is discussed. The dispersion equation derived for the Brillouin beam differs from one obtained previously without taking into account the surface current. The azimuthal electric field excited by the motion of the current ring is calculated, as well as the power loss due to the interaction of the current ring with this field. It is found that no power is radiated at frequencies exceeding the Langmuir frequency of the Brillouin cloud or at a certain critical frequency (less than the Langmuir frequency) which depends on the radius of the current ring. Expressions are derived for the limiting form of the radiated field and the power as the frequency approaches the Langmuir frequency. (ATD)

**32824** TRAVELING WAVES IN A NONLINEAR ELECTROMAGNETIC MEDIUM. Krasovitskii, V. B.; Kurilko, V. I. (Inst. of Physics and Tech., Kharkov). Zh. Tekhn. Fiz., 35: 580-2(Mar. 1965). (In Russian)

An investigation is made of the propagation of traveling waves without dissipation in a nonlinear two-level medium. A set of equations describing the interaction of electromagnetic waves in such a system consists of Maxwell equations and material equations of the medium. The solutions show that coupled longitudinal and transverse oscillations in the system are equivalent to oscillations of a particle in a two-dimensional potential well and that the steepness of the well's walls increases with the amplitude of the particle oscillations. Since the longitudinal and transverse oscillations are coupled, there is an exchange of energy between them. In the case when the amplitude of the longitudinal oscillations is small in comparison to that of the transverse oscillations, the former increases until it equals the latter. An inverse transformation of longitudinal waves into transverse waves proceeds analogously. (ATD)

**32825** ENERGY TRANSFER IN GASES. Institut International de Chimie fonde per Ernest Solvay Douzieme Conseil de Chimie held at Brussels University from November 5th till November 10th 1962. New York, Interscience Publishers, [1963]. 554p. (CONF-621101)

Separate abstracts were prepared for three of the twelve papers included. The remaining papers deal with scattering theory, energy transfer in atoms and molecules, problems in energy exchange related to chemical kinetics, shock tubes, shock-tube studies of electron excitation in gases, energy exchange in shock and detonation waves, vibrational energy relaxation, ultrasonics and energy transfer in gases, and kinetics of chain reactions. (D.C.W.)

*For abstracts of individual papers see: 32052, 32906, and 33084.*

**32826** INTEGRATION OF THE BOLTZMANN EQUATION OF CYLINDRICAL DISCHARGES INCLUDING SELF MAGNETISM AND EXTERNAL LONGITUDINAL MAGNETIC FIELDS. Stober, J. Thesis, Berlin, Humboldt-Universitat, 1964. 137p. (In German). $2.00(Gmelin, AED-DISS. 64-321).

A mathematical theory of transport phenomena of cylindrical discharges including self magnetism is given. Current density and heat current of electrons are calculated. (auth)

## Accelerators

*Refer also to abstract 33394.*

**32827** (AED-C-18-04) ACCELERATORS. Series C: Bibliographies. Mausberg, W. (comp.) (Institut fuer Kernphysik, Universitaet Frankfurt (West Germany)). Jan. 1965. 110p. Dep.(mn).

A total of 333 references are presented on the following subjects: auxiliaries, ion and electron sources, ray guides, lenses, ray deflection, focusing, magnetic fields, pulsing and bunching, high-frequency systems and resonators, beam measurements, electrostatic accelerators, cascade accelerators, microtrons, betatrons, electron and ion linear accelerators, synchrotrons, cyclotrons with and without sector focusing, FFAG, synchrocyclotrons, and applications. Report, patent, author and subject indexes are included. (D.L.C.)

**32828** (BNL-9213) THE DESIGN OF A MEDIUM-ENERGY PION BEAM (4-16 Gev/c) FOR THE BROOKHAVEN A. G. S. Read, A. L. (Brookhaven National Lab., Upton, N. Y.) Rubinstein, R. (Cornell Univ., Ithaca, N. Y. Lab. of Nuclear Studies). [1967]. Contract AT-30-2-GEN-16. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A pion beam is produced in a straight section of the Brookhaven A.G.S., by inserting a Be wire target in the circulating proton beam. The pion beam emerges at an angle of 4.5° with respect to the proton beam. Descriptions are given of the choice of target location and beam production angle; beam optics and transport system; computational methods for beam-parameter optimization and estimation of beam intensities, sizes, and divergences at various momenta; tabular and graphical results of these computations; beam-optimization procedures; and results obtained with the pion beam. (T.F.H.)

**32829** (NP-15056) SEKSTIPOL'NYE POLYUSNYE KORREKTIRUYUSHCHIE OBMOTKI USKORITELYA U-7. (Six-Field Pole Compensating Windings for the Accelerator U-7). Report No. 300. Talyzin, A. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1964. 20p. Dep.(mn).

Calculations of special pole windings for the C-type magnetic blocks of the ITEP 7-Bev proton synchrotron are presented. The windings excite in the magnet gap additional field characterized by a constant value of the second derivative of vertical field component with respect to radius or to height and radius. Results of magnetic measurements are presented. According to the measurements, some changes in the design of the windings were introduced.

**32830** (SLAC-40) EFFECT OF NUCLEAR RADIATION ON ORGANIC MATERIALS; SPECIFICALLY MAGNET INSULATIONS IN HIGH-ENERGY ACCELERATORS. Brechna, H. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Mar. 1965. Contract AT(04-3)-515. 93p. Dep.; $3.00(cy), 2(mn) CFSTI.

The coil insulation on most magnets for use with accelerators consists of inorganic materials such as glass fiber and fillers impregnated with organic compounds such as epoxies, polyesters, and silicones. Many of the usual combinations are damaged if subjected to high radiation levels such as those anticipated at the Stanford Linear Accelerator, where the expected dose rate may be as high as $10^{11}$ rads per year. Certain tests carried out at SLAC are described in which several commercially available insulations were found to deteriorate severely at total doses of as low as $10^{10}$ rads. Changes in molecular structure induced by radiation effects and degradation of electrical and mechanical properties are discussed. The development and testing of an insulation using pure $Al_2O_3$ fillers which have retained approximately 25% of its original mechanical strength at an absorbed radiation dose of $3.25 \times 10^{12}$ rads is described. This insulation requires minor changes in the usual winding and "potting" techniques prevalent in the industry. Interesting changes in the crystal structure of the filler are observed under irradiation. (auth)

**32831** (TID-21722) LOS ALAMOS MESON PHYSICS FACILITY (LAMPF). RADIO FREQUENCY POWER EQUIPMENT. Study Report. (Radio Corp. of America, Moorestown, N. J. Missile and Surface Radar Div.). July 31, 1964. For Los Alamos Scientific Lab., Univ. of California, N. Mex. Contract W-7405-eng-36, Subcontract LY-16004-1. 278p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

Major technical problems associated with the 805-Mc

equipment for the Los Alamos Meson Physics Facility (LAMPF) accelerator are studied. A set of recommendations for this 805-Mc equipment is presented. About fifty 1.25-Mw power amplifier systems are required in the 805-Mc system. (T.F.H.)

**32832** ENERGY MONITOR FOR ELECTRON ACCELERATORS. Okabe, Shigeru, Tabata, Tatsuo (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 51-5(Mar. 1965).

An energy monitor for electron accelerators was developed. It makes use of the elastic scattering of electrons by a foil placed in the beam path (the exit-window foil of the accelerator may also be utilized). The scattered electrons are magnetically analyzed and detected with an ionization chamber or a scintillation probe. It was experimentally verified that the energy spectrum can be monitored with a resolution of about 3% for electron beams of energies 4-15 Mev produced by a linear accelerator. (auth)

**32833** SECONDARY EMISSION BEAM POSITION MONITOR. Okabe, Shigeru; Tabata, Tatsuo (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 56-9(Mar. 1965).

A simple beam-position monitor, utilizing secondary emission and applicable to both pulsed and continuous-beam accelerators, is described. It does not intercept the beam and is especially suitable for accelerators of high output power. By making the diameter of its aperture approximately equal to that of the beam, good response characteristics can be obtained. An example of performance is given. A displacement of 0.5 mm is detectable for a beam of about 15-mm diameter. (auth)

**32834** PARTICLE ACCELERATORS AT THE INSTITUTE OF NUCLEAR RESEARCH. Koltay, Ede (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Fiz. Szemle, 15: 373-7(Dec. 1964). (In Hungarian)

In view of the absence of commercial firms engaged in the design and construction of accelerators, a development program was initiated jointly at the Institute of Experimental Physics of the Lajos Kossuth University and the Institute of Nuclear Studies of the Academy in Debrecen for solving the engineering and scientific problems of high-energy particle accelerators. The following devices were built: a 100-kev accelerator, using a Siemens-type Se rectifier tube; a 300-kev, one-stage, cascade-type generator with a homogeneous-field horizontal accelerator tube; an 800-kev, four-stage generator with an inhomogeneous-field Se rectifier and a remotely controlled r-f ion source; and a 1.8-Mev, four-stage Van de Graaff generator with an inhomogeneous-field accelerator tube and an r-f ion source. The latter is the largest regularly operating accelerator in Hungary. Plans are currently being prepared for a 5-Mev Van de Graaff accelerator and its associated laboratory. (TTT)

**32835** USE OF COCKROFT-WALTON ACCELERATOR FOR RADIOACTIVATION ANALYSES. Shchiokava, T. Genshiryoku Kogyo, 9: No. 6, 36-8(1963). (In Japanese)

The use of Cockroft-Walton accelerators in neutron activation analysis is discussed, with specific consideration of (d,n) reactions on $^{2}H$, $^{3}H$, and $^{9}Be$. The available fluxes and energies are considered, together with the accelerator potential requirements. A relation between $\sigma\theta/M$ ($\sigma$ = cross section, $\theta$ = isotope abundance, and M = gram-atomic weight) and the half-life and the sensitivity of the analysis is noted. Some analyses are summarized, showing the precision obtained and the techniques used. (D.C.W.)

**32836** RADIOISOTOPE PRODUCTION IN 20-Mev ELECTRON LINEAR ACCELERATOR. Tamura, T.; Tanaka, I.; Kuroyali, T. Genshiryoku Kogyo, 10: No. 2, 49-59(1964). (In Japanese)

Advantages in production of radioisotopes by high-intensity bremsstrahlung in a linear accelerator are given. A 20-Mev electron beam of the LINAC accelerator (Atomic Energy Research Institute of Japan) was focused to 4 mm dia and passed through a 1-mm aluminum foil into air, converted to bremsstrahlung with a 2-mm platinum foil, and then irradiated. The maximum electron beam power was 2 kw, 40% of which was bremsstrahlung. The target and product receiver were cooled with water, dry ice-alcohol, or a strong air current. At 20 Mev and 40 $\mu$a, the bremsstrahlung intensity was $5 \times 10^{6}$ R/min. For a high specific activity the radiation volume had to be 5-7 mm dia by 25 mm (about 1 ml); the volume dispersion of the bremsstrahlung tends to increase with increasing distance. Eighteen nuclides were studied: $^{18}F$, $^{22}Na$, $^{47}Ca$, $^{45}Ti$, $^{51}Cr$, $^{54}Mn$, $^{57}Co$, $^{74}As$, $^{88}Y$, $^{92}Nb$, $^{102}Rb$, $^{114}In$, $^{123}I$, $^{132}Cs$, $^{168}Tm$, $^{174}Lu$, $^{184}Re$, and $^{196}Au$. The yields and purity of these nuclides and the amounts of nuclides formed in the secondary reaction were measured with a 3-in.-dia by 3-in. NaI(Tl) crystal and a 256-channel pulse-height analyzer. The specific radioactivity of $^{47}Ca$ obtained by 10 hr irradiation of 200 mg of high-purity $CaCO_3$ was 36 $\mu$C/g, with a $^{45}Ca$ yield of $10^{-3}$. The radiochemical purities, yields, and specific radioactivities of $^{57}Co$ and $^{132}Cs$ obtained in 10 hr irradiation of 70 mg of a 99.99% nickel metal powder and 1 g of $^{133}CsCl$ were 99.5 and >99.9%, 6.4 and 10 $\mu$C, and 0.3 and 10 $\mu$C/g, respectively. Only the yields of $^{54}Mn$ and $^{74}As$ were measured, but the possibility of concentration by the Szilard-Chalmers effect was studied. The yields, purities, and half lives of $^{18}F$ and $^{45}Ti$ were also measured. The results showed that for nuclides with N > 100 the yield of light nuclei is sharply decreased, with a maximum activity of 1C/g; the purity of radioisotopes for the majority of nuclides may reach 99.9%; and the yield of the secondary reaction is not more than 0.1%. (P.C.H.)

**32837** A NEW RAPID METHOD FOR CONTROLLING THE EMISSION IN ELECTRON INJECTION INTO DESY (GERMAN ELECTRON SYNCHROTRON). Kynev, V.; Tim, U. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 11: 87-100(1963). (In Bulgarian)

In electron synchrotrons with energies over 1 Bev, for accurate, superior, and rapid work, it is a problem of decisive significance in nuclear experiments to bring the particles of the injector into the equilibrium orbit circuit. For the optimum standardization of the acceptance of a synchrotron, the phaseoptical focusing of the injected beam is necessary. The rapid and automatic correction of the quadrupolar magnetic lenses requires an effective control of the form and size of the phase surfaces of the injected beam into two directions perpendicular to each other, i.e., the knowledge of the emittance of the injector. A rapid method for the oscillographic observation of the phase surface of the injected beams for the purpose of the maximum coverage of DESY before it is put into operation was developed. An elliptical emittance and Gaussian distribution of the electrons in the beam of the 40-Mev linear accelerator (Linac) in DESY was assumed. On the basis of the transformation properties "/4" in the phase optics in the penetration of electron beams through quadrupole magnetic lenses, it was proved that it is possible to measure the emittance by pulse analysis of the phase surface and synthesis of its electron image on the luminescent screen. A new circuit for the proposed rapid method was developed and the corresponding electronic measurement devices were designed and constructed. (tr-auth)

**32838** VACUUM PROBLEMS OF ELECTRON AND POSITRON STORAGE RINGS. Bernardini, M.; Malter, L. (Laboratori Nazionali, Frascati, Italy and Varian Associates, Palo Alto, Calif.). J. Vacuum Sci. Technol., 2: 130-41(May-June 1965).

The problem of gas evolution in electron-positron storage rings due to synchrotron radiation was explored. The spectral distribution of the radiation was first computed. From this and from data on quantum efficiency it was possible to determine an upper limit to the resultant photoemission from the ring walls. Measurements of the desorption efficiency from stainless steel 304 then made possible a determination of the maximum gas load which could be expected as a result of the synchrotron radiation. This treatment was applied to a planned storage ring to be

built at Frascati. From this it appeared that with modest processing the ring walls could be put into a condition such that the gas evolution would have completely acceptable values. The effects of wall temperature and of processing in hydrogen and oxygen upon the desorption efficiency were determined. On the basis of the results obtained it is concluded that optimum results would be obtained by the use of materials which are gas-free and on which tightly bound layers are formed from the ambient atmosphere. (auth)

**32839** AXIAL FIELD PLASMA BETATRON. Miyamoto, Goro; Iwata, Giichi (Tokyo Univ.). Kakuyugo-Kenkyu, 14: 373-432(Apr. 1965). (In Japanese)

In part I, introductory remarks and the description of the axial field plasma betatron are given. In part II, calculations concerning the motion of electrons in this machine are given, and it is shown that electrons can be accelerated to 500 kev when the confining magnetic field is 3kG. The energies of electrons determined from measurements of x rays from a target were a little lower. In part III, preionized plasma was measured by a double probe. Plasma of $T_e \cong 4$ ev, $n \cong 10^{12}$ cm$^{-3}$ was obtained, and it decayed by diffusion according to 1/13 law. In part IV, the energy of the accelerated electrons in plasma was measured in the various conditions. Maximum energy of about 300 kev was observed with $4 \times 10^{-4}$ mm Hg helium. It reached about 1 Mev when helium was absent and the pressure was $3 \times 10^{-5}$ mm Hg. In part V, direct measurements of energy distribution of x rays as one method of energy determination of electrons are described. The results from this are compared with those from the absorption method. In part VI, the electron temperature of the plasma was measured spectroscopically; it was about 40 ev. (auth)

**32840** FUTURE TRENDS IN PARTICLE-ACCELERATOR DESIGN. Blewett, John P. (Brookhaven National Lab., Upton, N. Y.). Nucleonics, 23: No. 6, 50-4(June 1965).

The most important efforts in accelerator development reported at the Particle Accelerator Conference in Washington, D. C. are summarized, involving superconducting r-f cavities, storage-ring progress, large proton accelerators, meson factories, cyclotrons, linear-accelerator intensities, and electron-synchrotron energies. (D.C.W.)

**32841** POSSIBILITIES OF PARTICLE ACCELERATION USING MULTIPLE RESONANCE FREQUENCIES IN 10-Gev SYNCHROPHASOTRON. Kazanskii, G. S.; Mikhailov, A. I.; Puchkov, G. P.; Tsarenkov, A. P.; Chekhlov, K. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 21-5(Mar.-Apr. 1965). (In Russian)

The possibility of the acceleration of proton beams in the synchrophasotron, with a frequency of the accelerating voltage, was investigated for multiple frequency of revolution of the accelerating particle beams. The data of the theoretical and experimental results were analyzed and the possible variants for the modernization of the high frequency apparatus for the power supply were examined. The theoretical analysis of the multiple frequency regime by increased injection energy was given. The direction of work in accordance with the new system is recommended. (tr-auth)

**32842** BETATRON INTERNAL TARGET. Kochevanov, V. A. (Leningrad State Univ.). Pribory i Tekhn. Eksperim., No. 2, 26-30(Mar.-Apr. 1965). (In Russian)

Simple constructions for betatron internal targets, completely prepared from quartz, were proposed. The target is not heated by the work of the betatron and it is sufficiently stable so that it withstands atmospheric pressure and high radiation doses. Internal targets of such construction appear very convenient for the study of the effect of high energy electrons in optical media and for photoactive determination of oxygen and other elements in the metals, in their alloys, and in some other materials. (tr-auth)

**32843** HIGH-SPEED TRANSISTOR MAGNETOMETER. Voronin, V. S.; Kanunnikov, V. N. Pribory i Tekhn. Eksperim., No. 2, 160-3(Mar.-Apr. 1965). (In Russian)

A magnetometer that can be used for the continuous measurement of a constant magnetic field in the range from 0 to 80 gauss correct to ±0.05% ±0.01 gauss was described. The reaction time of the device is $10^{-3}$ sec; the output is proportional to the field intensity at direct current from 0 to 220 mamp. The magnetometer is used for magnetic measurements in the electron ring phasotron FIAN, as well as in the stabilization system of the primary field of this accelerator. (tr-auth)

**32844** CONTROL OF THE CHARGED PARTICLE BEAM BOMBARDING A THIN TARGET IN THE JINR SYNCHROPHASOTRON. Kazanskii, G. S.; Tsarenkov, A. P. Zh. Tekhn. Fiz., 35: 414-15(Mar. 1965). (In Russian)

A method for controlling the proton beam of the JINR 10-Bev synchrophasotron that was developed in connection with a proton-proton scattering experiment is discussed briefly. Approximately 0.5 sec before the beam current reaches its plateau those particles that execute vibrations of large amplitude about the equilibrium orbit are removed by a special interception target. Subsequent acceleration takes place at a radius far from the position of the working target. When the magnetic field reaches its maximum (plateau) the beam is brought to the target by a change of the frequency of the accelerating potential and is subsequently maintained there by an inverse feedback system. The system is adjusted so as to maximize the ratio of the number of particles interacting with the target to the total number of particles in the bunch. This ratio is ordinarily from 0.4 to 0.5. (ATD)

**32845** THEORETICAL ANALYSIS OF THE PARTICLE EXTRACTION PROCESS IN A STRONG-FOCUSING SYNCHROTRON UNDER PARAMETRIC RESONANCE CONDITIONS. Shukeilo, I. A. Zh. Tekhn. Fiz., 35: 421-7(Mar. 1965). (In Russian)

The solutions of the equation for radial betatron oscillations in a strong focusing synchrotron are discussed. The equation discussed includes in the expression for the axial component of the magnetic field in the vicinity of the orbit a term proportional to the cube of the distance from the equilibrium orbit. The inclusion of this term is regarded as much more important in the strong focusing than in the weak focusing case. Expressions are derived for the buildup time and phase bunching of the betatron oscillations under the assumption that the extraction process is initiated by an instantaneous shift of the betatron oscillation frequency to the resonance value. The influence of the cubic term in the axial magnetic field component is illustrated by numerical calculations for typical values of the parameters. It is concluded that parametric excitation of resonance betatron oscillations can be usefully employed for beam extraction from strong focusing synchrotrons, but that the most efficient beam extraction would probably be achieved by a combination of methods. (ATD)

**32846** CALCULATION OF THE PHASE VELOCITY OF WAVES IN THE IRIS WAVEGUIDE OF A LINEAR ACCELERATOR. Zykov, A. I.; Makhnenko, L. A. Zh. Tekhn. Fiz., 35: 489-95(Mar. 1965). (In Russian)

A method is developed for calculating the resonant frequency and phase velocity in a septate waveguide of circular cross section of the type employed in linear electron accelerators. The field within the waveguide is treated as that of the fundamental $E_{01}$ wave which had undergone repeated reflection at the septa. The requisite formulas for the reflection coefficient and phase shift are derived and their application is illustrated. Results of calculations performed for a septate waveguide operating in the $\pi/2$ mode are compared with previous data. It is shown that the calculation method involves a small systematic error, which is ascribed to the neglect of higher modes excited at the septa. This error can be compensated by replacing the cell length by a shorter effective length. The difference between the true and effective cell lengths increases with increasing phase

shift per cell; for a $\pi/2$ phase shift this difference is 3%, and for a $3\pi/2$ phase shift, the difference is 5%. It is concluded that the proposed method is sufficiently accurate for linear accelerator design calculations and is much simpler than other methods commonly employed for this purpose. (ATD)

**32847** CALCULATION OF THE FIELD STRENGTH IN A TRAVELING-WAVE LINEAR ACCELERATOR. Makhnenko, L. A.; Zykov, A. I.; Kramskoi, G. D. Zh. Tekhn. Fiz., 35: 496-501(Mar. 1965). (In Russian)

The method for calculating the characteristics of a septate waveguide of circular section of the type employed in linear electron accelerators by treating the field within the waveguide as that of the fundamental $E_{01}$ wave multiply reflected at the septa is applied to the calculation of the field strength within the waveguide. The excitation at the septa of $E_{on}$ waves with n greater than unity is neglected. The method should accordingly be suitable when such excitation is small, and this is usually the case for a waveguide in which the phase velocity is that of light and the phase shift per cell is $\pi/2$. The field strength within the waveguide is defined as the energy gained per unit path length by a relativistic electron traveling in an optimal trajectory, and the requisite formulas for calculating it are derived. The ratio of the field strength to the square root of the power in a septate waveguide in which the phase velocity is that of light and the phase shift per cell is $\pi/2$ was calculated for values of the ratio of the diameter of the iris to that of the waveguide from 0.24 to 0.40, and the results are presented graphically and compared with previous calculations and two experimentally measured field strengths. Excellent agreement is shown between theory and experiment, and it is concluded that the method of calculation is suitable for practical applications. (ATD)

**32848** CALCULATION OF THE GROUP VELOCITY AND DAMPING OF WAVES IN THE SEPTATE WAVEGUIDE OF A LINEAR ACCELERATOR. Zykov, A. I.; Makhnenko, L. A. Zh. Tekhn. Fiz., 35: 502-7(Mar. 1965). (In Russian)

The method for calculating the characteristics of a septate waveguide of circular cross section of the type employed in linear electron accelerators by treating the field within the waveguide as that of the fundamental $E_{01}$ wave multiply reflected at the septa is applied to the calculation of the group velocity and damping of the waves within the waveguide. Simple formulas for the group velocity and the damping constant are derived. The group velocity is calculated by dividing the energy flux by the energy density, and the damping is assumed to be due to the loss of Joule heat in the wall of the smooth portion of the waveguide, the Joule heat lost in the septa being neglected. The group velocity and damping constant in a copper septate waveguide in which the phase velocity is that of light and the phase shift per cell is $\pi/2$ was calculated for values of the ratio of the diameter of the iris to that of the waveguide from 0.24 to 0.40, and the results are presented graphically and compared with experimental data. Excellent agreement is shown between the measured and calculated group velocities. The fact that the calculated damping constants were not in as good agreement with the experimental values is ascribed to the sensitivity of this quantity to the condition of the waveguide wall surface. It is concluded that the present simple method is sufficiently accurate for design calculation purposes provided the excitation of $E_{on}$ waves with n greater than unity at the septa can be neglected, and it is asserted that this condition is met by the majority of septate waveguides employed in traveling wave linear accelerators. (ATD)

**32849** DETERMINATION OF THE EQUIVALENT REFLECTION COEFFICIENT OF THE SEPTATE WAVEGUIDE OF A LINEAR ACCELERATOR. Zykov, A. I.; Makhnenko, L. A.; Kramskoi, G. D. Zh. Tekhn. Fiz., 35: 508-10(Mar. 1965). (In Russian)

The reflection coefficients of septate waveguides of circular cross section of the type employed in linear electron accelerators were measured. The reflection coefficient is required for calculating the characteristics of the waveguide by the method in which the field within the waveguide is treated as that of the fundamental $E_{01}$ wave multiply reflected at the septa. The reflection coefficient was determined by measuring the standing wave ratio in a rectangular feeder section coupled to the septate waveguide by a transformer from $H_{01}$ to $E_{01}$ waves; the septate waveguide ended in a matched section closed by a nonreflecting load. Measurements were performed for three septate waveguides, in all of which the phase shift per cell was $\pi/2$ and in two of which the phase velocity was that of light. The results are tabulated and compared with reflection coefficients calculated previously. The excellent agreement obtained between the experimental and theoretical values of the reflection coefficients is regarded as evidence that the approximations involved in the theory are justified and that the theory can be successfully employed for other calculations. The theory can also be employed to calculate the characteristics of periodic systems with more complex geometry by using measured values of the reflection coefficient. (ATD)

**32850** ON A POSSIBLE METHOD FOR CALCULATING THE ENVELOPE TRAJECTORY OF THE PARTICLES IN AN ACCELERATOR. Lembra, Yu. Ya. (Tartu State Univ., USSR). Zh. Tekhn. Fiz., 35: 574-5(Mar. 1965). (In Russian)

A method is presented for calculating the square of the modulus of the Floquet function for betatron oscillations, required for focusing calculations by the envelope method, without resort to calculations involving complex quantities. It is shown that the periodicity matrix of Courant and Snyder, which is simply defined in terms of the Wronskian of the two fundamental solutions of the betatron oscillation equation, not only determines by its diagonal elements the phase shift of the betatron oscillations per periodicity element but is also closely related to the Floquet function. The square of the modulus of the Floquet function can be calculated from the periodicity matrix without employing complex quantities. (ATD)

**32851** MAGNETIC BODY FOR A PARTICLE ACCELERATOR. Lang, Herman; Radebold, Reinhart; Koerber, Arnold (to Licentia Patent-Verwaltungs GmbH). German Patent 1,187,750. Feb. 25, 1965. Filed June 13, 1961.

A magnet for cyclic accelerators is given which is a figure of revolution and comprises two pole pieces provided with coils for the magnetic excitation and a magnetic body of high density concrete mixed with iron which encloses the pole pieces, the coil and the accelerating chamber almost entirely. The part by weight of iron or steel contained in the high density concrete amounts to at least half of the total weight. (Gmelin Inst.)

# Astrophysics and Cosmology

*Refer also to abstracts 33118, 33119, and 33137.*

**32852** (AD-608730) BASIC SOLAR RESEARCH. Annual Report, October 1, 1963–October 1, 1964. Mohler, O. C. (Michigan Univ., Ann Arbor. Dept. of Astronomy). Contract Nonr-1224(19). 10p. $1.00(CFSTI).

Research at McMath-Hulbert Observatory during the period Oct. 1, 1963 to Sept. 30, 1964, on solar flares, solar activity, and solar terrestrial relations is reviewed. Projects are discussed on initial survey and organization of spectroheliographic records of solar activity, 1958 to 1961; analysis of wavelength-sweep records for July 16, 1959, and June 25, 1960; working list of flares and daily flare index for 1963; general relations between flares, ionospheric, and geomagnetic disturbances for 1957 to 1961; solar activity at start and end of first six months of the International Years of the Quiet Sun; unexpected effect related to 29.5 days in cosmic ray data; magnetic fields of large sunspots; magnetic classification of sunspots in the Mount Wilson system, 1963 to 1964; supplication of hydromagnetic theory to the sun; decrease in intensity at the solar

limb during the July 20, 1963, eclipse; profiles of weak iron lines; measurement for various groups of lines in the solar spectrum; relative abundances of chemical elements in the solar atmosphere. (auth)

**32853** (AD-610847) [RESEARCH PROGRAM IN PHYSICS AND ASTROPHYSICS: ASTROPHYSICS, PLASMA PHYSICS, AERODYNAMICS, NUCLEAR PHYSICS AND SPECTROSCOPY. Report for October 1–December 31, 1964]. Lewis M. Branscomb (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). Feb. 8, 1965. Contract DA-31-124-ARO(D)-139. 17p. $1.00(CFSTI).

Studies are made of plasma statistics, aerodynamics, atomic collisions, atomic resonance, ultraviolet spectroscopy, and reaction rates with a view to applying the results to astrophysical problems. (auth)

**32854** (LA-3320(p.100-3)) LABORATORY ASTROPHYSICS. Cowan, R. D.; Peacock, N. J.; Sawyer, G. A.; Thomas, K. S. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

A C-strap source is constructed from an ingot-iron C strap with pure Fe electrodes. The source is inserted in Scylla I discharge tube. The Fe-ion spectrum is measured and compared with the solar Fe-ion spectrum. The results are tabulated and shown graphically for Fe VIII, IX, X, XI, and XII lines. (T.F.H.)

**32855** EXPERIMENTAL DETERMINATION OF ABSOLUTE INTENSITIES IN THE SOLAR XUV SPECTRUM. Hinteregger, H. E. (Air Force Cambridge Research Labs., Bedford, Mass.). Ann. Astrophys., 28: 123-4 (1965).

Experimental problems of absolute intensity measurements of solar electromagnetic radiation in the extreme ultraviolet (EUV) and soft x-ray region of the spectrum (designated cumulatively as XUV for brevity) are reviewed. From an evaluation of existing rocket and satellite data, together with existing projects and goals of future observations from space vehicles, it is suggested that the numerous associated practical problems be divided into two major areas, namely: the general experimental art of heterochromatic absolute XUV spectrophotometry in the lab, and specific problems characteristic of the objectives of solar physics as well as existing restrictions of space technology. In a discussion of these problems it is reported that the use of synchrotron radiation has been considered for the calibration of extreme-uv satellite spectrometers and it was concluded that the use of the polarized synchrotron beam to calibrate a grating instrument which is then used to examine a source of unknown polarization may introduce an additional uncertainty. As an alternative, the characteristic radiation produced by electron bombardment of light elements, at wavelengths of 113 Å and below, was used. However, the polarization of the synchrotron radiation is probably an advantage rather than a disadvantage, because this polarization is well-known and therefore effects of polarization can be studied and the case of completely unpolarized light be constructed from suitable experiments. With respect to solar EUV spectrophotometers of the type using gratings in grazing incidence, it is suggested that differences in the polarization of lab test sources and the actual solar radiation respectively have contributed only insignificant errors in the overall process of determining absolute intensities of solar XUV radiation. As for the best present value for the total flux of solar quanta with more than ~12 ev ($\lambda < 1000$ Å), it is suggested that the present value for the flux of solar quanta of photon energies greater than 12 ev is not drastically different from previously reported values. For present average conditions of a quiet sun, it is estimated that this value is of the order $5 \times 10^{10}$ cm$^{-2}$ sec$^{-1}$, or, expressed in terms of energy flux density, about 2 erg cm$^{-2}$ sec$^{-1}$. (BBB)

**32856** SOLAR X RADIATION. DeJager, C. (Rijksuniversiteit, Utrecht). Ann. Astrophys., 28: 125-31 (Jan.-Feb. 1965).

Solar x-ray bursts, which are associated with solar flares and radio phenomena are treated. The x-ray bursts are defined as electromagnetic radiation originating from electronic transitions involving the lowest electron shells; gamma rays are of nuclear origin. The x-rays are divided into two classes according to the origin: quasi-thermal x-rays, which are emitted by the quiet corona, the activity centers without flares, and x-ray flares; and non-thermal x-ray bursts, which are always associated with flares. The flare-associated bursts are further subdivided, and a description is given of each class. (L.B.S.)

**32857** RECENT SOLAR X-RAY STUDIES IN THE UNITED KINGDOM. Pounds, K. A. (Univ. of Leicester, Eng.). Ann. Astrophys., 28: 132-45(Jan.-Feb. 1965).

Solar x-ray data are reviewed, which include several new x-ray events reduced from the Ariel satellite results, soft x-ray flux measurements from NRL satellite 1963-21 C and notes on recent rocket studies in this field. A brief discussion is added on the nature of solar flare x-rays and their measurement. (auth)

**32858** HIGH-ENERGY COSMIC PHOTONS AND NEUTRINOS. Gould, R. J.; Burbidge, G. R. (Univ. of California, San Diego, La Jolla). Ann. Astrophys., 28: 171-201(Jan.-Feb. 1965).

A review is given on the problem of interpreting the recent X-ray and $\gamma$-ray observations of celestial sources. The expected fluxes of hard radiation from various processes are estimated and are compared with the observations. The synchrotron, bremsstrahlung, and (inverse) Compton spectra originating from relativistic electrons produced (via meson production) in the galaxy and intergalactic medium by cosmic ray nuclear collisions are computed; the spectra from $\pi^0$-decay are also computed. Neutron stars, stellar coronae, and supernova remnants are reviewed as possible X-ray sources. Special consideration is given to the processes in the Crab Nebula. Extragalactic objects as discrete sources of energetic photons are considered on the basis of energy requirements; special emphasis is given to the strong radio sources and the possibility of the emission of hard radiation during their formation. The problem of the detection of cosmic neutrinos is reviewed. As yet, no definite process can be identified with any of the observed fluxes of hard radiation, although a number of relevant conclusions can be drawn on the basis of the available preliminary observational results. In particular, some cosmogonical theories can be tested. (auth)

**32859** UPPER LIMITS TO THE FLUX OF HIGH ENERGY $\gamma$-RAYS FROM SELECTED QUASI-STELLAR AND OTHER SOURCES, USING THE ČERENKOV TECHNIQUE. Long, C. D. (University Coll., Dublin); Porter, N. A.; Weekes, T. C.; Fruin, J. F.; Jelley, J. V. Ann. Astrophys., 28: 263-4(Jan.-Feb. 1965).

Upper flux limits at the earth for $\gamma$ rays of energy greater than about $5 \times 10^{12}$ ev, have been established for the quasi-stellar sources 3C 147, 3C 196 3C 273, the Crab Nebula, and the magnetic variable 53 Cam. They are all of the order $10^{-10}$ photons cm$^{-2}$ s$^{-1}$. Corresponding upper energy limits at emission are of the order $5 \times 10^{47}$ ergs s$^{-1}$ for the quasi-stellar sources, and $5 \times 10^{35}$ ergs s$^{-1}$ for the Crab Nebula, if $\gamma$-ray absorption is assumed negligible. Possible absorption mechanisms are discussed. (auth)

**32860** MODIFIED SPHERICAL HARMONIC METHOD AND SPHERICAL GEOMETRY. II. TRANSFER PROBLEM IN SPHERICALLY SYMMETRIC FINITE STELLAR ATMOSPHERE. Wilson, S. J.; Sen, K. K. (Univ. of Singapore). Ann. Astrophys., 28: 348-52(Mar.-Apr. 1965).

The modified double-interval spherical harmonic method developed previously was extended to solve the equation of transfer for finite spherically symmetric stellar atmospheres with $k\rho \propto r^{-2}$. The results were compared with those of Chandrasekhar obtained by the method of Gaussian quadrature. (auth)

**32861** EVOLUTION OF SPECTRA OF EXTRAGALACTIC RADIOSOURCES. Lequeux, James (Observatoire de Paris). Ann. Astrophys., 28: 360-79(Mar.-Apr. 1965). (In French)

It is shown that the spectra of the best known extragalactic radio sources depend mainly upon their linear dimen-

sions; the smallest sources exhibit at the low-frequency end a curved spectrum with a small slope. On the other hand, it is impossible to find any relation between the intrinsic intensity of the source and its spectrum except at very low frequencies. To account for their properties, particularly spectral properties, a model of the evolution of these extragalactic radio sources was constructed. It is assumed that one or more explosions in the center of a galaxy generate relativistic electrons or heavier particles which will give secondary electrons by collisions with interstellar nuclei. The particles spread rapidly in the galactic magnetic field without loss of energy. If the total energy of these particles is smaller than the magnetic field energy, the particles will be trapped so that they will form a rather small, weak and stable radio source (normal galaxy). The spectrum of the relativistic electrons will remain the same as the initial spectrum, thus providing an explanation of the fact that the radio spectra of the normal galaxies are similar to those of very young sources, even very bright ones. If the energy of the relativistic particles exceeds the magnetic energy, the source size will increase continuously. Its shape will exhibit double structure controlled by the configuration of the galactic field. The two components undergo a moderate adiabatic expansion. The relativistic electrons will lose some energy which will cause the radio flux to decrease and the spectrum to move towards lower frequencies. The spectrum will tend to become straight with a steep slope. Some secondary phenomena, such as synchrotron losses, might further modify the spectra of old sources. 77 references. (auth)

**32862** EFFECT OF INELASTIC COLLISIONS ON THE DISTRIBUTION FUNCTION OF ELECTRONS IN ASTROPHYSICAL CONDITIONS. Souferin, S. (Institut d'Astrophysique, Paris). Ann. Astrophys., 28: 399-411(Mar.-Apr. 1965). (In French)

The effect of inelastic collisions on the distribution function of electron velocities was investigated under the conditions prevailing in astrophysics. A complete set of equations dependent on two parameters (temperature of the ions and atoms, electron density) was established for a gas not in local thermodynamic equilibrium. The differences from the Maxwellian distribution obtained under the conditions pertaining to stellar chromospheres are insufficient to perturb observably the populations of the levels and the ionization of the gas. (auth)

**32863** SPONTANEOUS FISSION TRACKS FROM EXTINCT $Pu^{244}$ IN METEORITES AND THE EARLY HISTORY OF THE SOLAR SYSTEM. Fleischer, R. L.; Price, P. B.; Walker, R. M. (General Electric Research Lab., Schenectady, N. Y.). J. Geophys. Res., 70: 2703-7(June 1, 1965).

A new method is proposed for exploring the early history of the solar system, based on the search in meteoritic crystals for fossil fission tracks from the presently extinct isotope $^{244}Pu$ (half-life = $7.6 \times 10^7$ years). The method involves experimental techniques developed for dating terrestrial minerals; it is simple and applicable to many meteoritic minerals. If such tracks can be definitely identified, it is possible to infer values for $\Delta T_0$, the time interval between the end of nucleosynthesis and the formation of cooled meteoritic material. The method is described, and experimental results giving evidence for Pu tracks in two meteorites are presented. Alternative explanations are considered and are shown to be less likely. (auth)

**32864** THE USE OF PHOTOGRAPHIC EMULSIONS IN ROCKET STUDIES OF THE SOLAR X-RADIATION. Pounds, K. A. (Univ. of Leicester, Eng.). J. Phot. Sci. 13: 20-4(Jan.-Feb. 1965).

Two photographic instruments suitable for the studies of solar imaging and high resolution spectroscopy are described. These are the spectroheliograph and crystal spectrograph. By use of Fresnel zone plate photography, it should be possible to improve the solar pointing accuracy to about 20 arc sec. Suitable x-ray films for each system are described. The gelatin supercoat, which is present on most commercial x-ray films, has the serious disadvantage for work in the 1-100 Å region of making the film sensitivity highly nonuniform with wavelength. A 2-$\mu$ supercoat, for example, transmits over 99% of incident 2-Å x rays, 48% of 12-Å radiation, and less than 0.05% at 43 Å. To overcome this problem, several films have been obtained without a supercoat, and films of this type have been used in the instruments described. (TCO)

**32865** AUTOCORRELATION OF SOLAR ACTIVITY. Altschuler, Martin D.; Sastry, Ch. V. (Yale Univ., New Haven). Nature, 206: 1035-6(June 5, 1965).

The autocorrelation function, R, of various indexes of solar activity over time-lags, $\tau$, of 1 to 200 days was examined. Data were analyzed for the years 1957-58 and 1960-63. The 1957-58 sunspot correlogram appeared to possess a periodicity of approximately 93 days, but the autocorrelograms of 1960-63 did not show the 93-day periodicity. (M.C.G.)

**32866** OSCILLATION PERIODS OF NEUTRON STARS. Tsuruta, Sachiko (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Wright, James P.; Cameron, A. G. W. Nature, 206: 1137-8(June 12, 1965).

It was previously suggested that x-ray emission from celestial sources might be associated with the mechanical energy of radial oscillations of neutron stars. The possible effects of nuclear forces on such oscillation periods were studied. The circular frequency for purely radial oscillations in general relativity was used in the calculations. Three types of nuclear forces were chosen: a three-body nuclear potential and two neutron-neutron potentials. The case of non-interacting fermions was also considered for comparison. Results of calculations are presented in graphs. One conclusion was that an attractive force tends to decrease the oscillation periods. (M.C.G.)

**32867** RELATIVISTIC ASTROPHYSICS. Weidemann, V. (Technische Hochschule, [Munich]). Naturwissenschaften, 52: 149-53(1965). (In German)

The most important aspects of the theoretical and experimental data on relativistic astrophysics reported in the last year are summarized. Relativistic astrophysics, radiogalaxies and quasistellar radio sources, cosmic radiation, cosmic gamma, x, and neutrino radiation, and gravitational collapse are considered. (J.S.R.)

**32868** ELLIPTICAL POLARIZATION OF THE CONTINUOUS RADIATION OF THE CRAB NEBULA. Oetken, Lore (Astrophysikalisches Observatorium, Potsdam, Ger.). Naturwissenschaften, 52: 153-4(1965). (In German)

A series of photographs were made for the complete determination of the polarization state (polarization degree and direction and ellipticity) of the Crab Nebula continuum at 5700 Å. The results showed that the light at least in given regions of the nebula is polarized elliptically. It was assumed that the nebula radiation itself is elliptically polarized. The measurements also showed a weak ellipticity from almost all parts of the nebula which can be considered as originating from the interstellar medium. (J.S.R.)

**32869** NEUTRINO PRODUCTION IN THE $^3He(p,e^+\nu)^4He$ REACTION IN SOLAR INTERIORS. Kuzmin, V. A. (Lebedev Inst. of Physics, Moscow). Phys. Letters, 17: 27-8 (June 15, 1965).

The neutrino flux being produced in the sun in the rare termination of the proton-proton chain by a direct $\beta$ process is discussed. Neutrinos produced in this reaction have the hardest $\beta$ decay momentum spectrum and contribute to the values of effects caused by solar neutrino flux in high threshold detectors at the earth. It is hoped that that contributions of $^8B$ and ($^3He$,p) neutrinos can be separated in order to study the internal structure of the sun. (J.F.P.)

**32870** ABSOLUTE STABILITY OF MELVIN'S MAGNETIC UNIVERSE. Thorne, Kip S. (Princeton Univ., N. J.). Phys. Rev., 139: B244-54(July 12, 1965).

The physical structure of Melvin's magnetic universe is briefly examined and its dynamical behavior under arbitrarily large radial perturbations is discussed. It is shown that

no radial perturbation can cause the magnetic field to undergo gravitational collapse to a singularity or electromagnetic explosion to infinite dispersion. Rather, when arbitrarily perturbed inside a finite region, the magnetic and gravitational fields undergo damped, turbulent oscillation until they have radiated away from the perturbed region all the energy associated with the perturbation. Then they settle down into Melvin's unperturbed, static configuration. (auth)

**32871** PROPOSAL FOR THE DETECTION OF DISPERSION IN RADIOWAVE PROPAGATION THROUGH INTERGALACTIC SPACE. Haddock, F. T. (Univ. of Michigan, Ann Arbor); Sciama, D. W. Phys. Rev. Letters, 14: 1007-8(June 21, 1965).

The possibility of detecting the ionized intergalactic gas which has been postulated previously is considered. The recent discovery that the quasistellar radio source CTA 102 may be a radio variable with a period of about 100 days suggests that detection is possible. Intergalactic dispersion of the radio waves would be indicative of the ionized gas. (M.O.W.)

**32872** EVOLUTION OF GALAXIES. DEVELOPMENT OF ITS RESEARCH IN JAPAN. Hatanaka, Takeo (Tokyo Univ.); Hayakawa, Satio; Ishida, Keiichi; Taketani, Mituo. Progr. Theoret. Phys. (Kyoto), Suppl. No. 31, 2-34(1964).

A general review is given of investigations of the structure and the evolution of galaxies. A historical review is given of the development of nuclear astrophysics and cosmical gas dynamics in Japan. A summary of observational information on galaxies and also a suggestive discussion on the evolution of galaxies are presented. For understanding the evolution of galaxies the dynamical behavior of a system of gas clouds is found to be essential, which is intuitively described. A view on the evolution of galaxies is given, starting from a primordial gas of high temperature to the formation of galaxies of various types. Morphological features of clusters of galaxies and of galaxies are shown to be characterized by two parameters, the random velocity of clouds and the rotational velocity of a system of clouds. If, for example, the random velocity is small, the cluster of galaxies is spherical and the galaxies formed therein are mainly spherical, massive and densely populated. A review is introduced in which properties of the galactic nucleus and radio galaxies are discussed, and the role of such activities in the evolution is emphasized. The structure and the evolution of spiral galaxies as well as the stability of arms are reviewed. It is remarked that the structure of arms is probably reconstructed in every $10^8$ years. (auth)

**32873** RADIO GALAXIES. Aizu, Ko (Rikkyo Univ., Tokyo); Fujimoto, Yoichi; Hasegawa, Hiroichi; Kawabata, Kin-aki; Taketani, Mituo. Progr. Theoret. Phys. (Kyoto), Suppl. No. 31, 35-61(1964).

Explosive phenomena in galaxies including starlike objects are analyzed from the point of view that they represent an important stage of the evolution of most of galaxies. The number of active galaxies estimated on this view is shown to agree with the observed one. In order to study the evolutionary track of galaxies in and after an explosion, a new diagram, called L−L/V diagram, is introduced, which shows the relation between the radio luminosity and the volume emissivity. Two types of evolutional sequences are found: giant sequence including starlike objects, and normal sequence, a typical example of which is found in the Virgo cluster. Supernovas plotted in the same diagram show a striking similarity of their evolution with that of radio galaxies. The pile theory is proposed for the mechanism of an explosion. Because of the strong static and dynamical interaction between stars and gas in the core of a galaxy, the evolution of a star is accelerated and simultaneous explosion of stars takes place with strong optical emission. The expansion and interaction with a surrounding medium of gas ejected in an explosion is discussed. For the formation of the galactic halo and the transit formation by an explosion of the core another possibility of the accretion of intergalactic matter onto a galaxy is pointed out and a criterion for these two cases is proposed. Finally extragalactic cosmic rays are discussed assuming a parallelism between radio emission and cosmic ray production in a galaxy. In the Appendix data on 156 radio-emitting galaxies are collected and analyzed. (auth)

**32874** DATA ON NORMAL AND RADIO GALAXIES. Aizu, Ko; Tabara, Hiroto (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), Suppl. No. 31, 62-76(1964).

Optical and radio data are tabulated for 101 normal galaxies and for 55 radio galaxies. The extragalactic radio sources with radio luminosity $L < 10^{41}$ erg/sec are classified as normal galaxies and those with $L > 10^{41}$ erg/sec as radio sources. (L.B.S.)

**32875** FORMATION OF SPIRAL ARMS AND DYNAMICAL MODEL OF BARRED GALAXIES. Oki, Tosio; Fujimoto, Mitsuaki; Hitotuyanagi, Zyuiti (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), Suppl. No. 31, 77-115 (1964).

The dynamical model of gas in spiral and barred galaxies is discussed. Theories that have been proposed to account for the formation of spiral arms are briefly reviewed. A new model is then proposed in which both gravitational and magnetic fields are taken into consideration. Solutions of the basic equations for the model are obtained by using a parameter which measures the ratio of magnetic to gravitational potential energy and by making a perturbation expansion in this quantity. It is found that for appropriate initial magnetic fields, a spiral arm can be formed as a locus of the points of maximum density of gas and the symmetry of spiral arms can be explained. Noncircular motions of gas, outflow and lag in rotational velocity of gas are also discussed. The time scale for the arm formation as well as for the growth of magnetic induction in the arm is found to be of the order $2 \times 10^8$ years. Several consequences derived from the theory are discussed. It is shown that, if a turnover point exists in the galactic rotation curve, the ring-structure as observed in some galaxies can be formed around this point, superposed on the spiral structure. To reconcile the disparity between the time scale of spiral arms and the age of galaxies, a hypothesis is made that a kind of stationarity may be established in the galactic plane, once the spiral arm is formed with the degree of winding as observed in actual galaxies, that is, angular momentum and magnetic field intensity will remain unchanged for a larger time interval than the above time scale. To test this it is assumed that in our galaxy there exists the region of instability for circular orbit inside the 3 kpc-arm that works like a pump through which mass and angular momentum of the halo flow into the disk. The supply of angular momentum by this would be sufficient to drive a large scale galactic circulation of gas, but the arguments are not conclusive. A dynamical model of barred galaxies is described. The possibilities are confirmed of the outflow of gas along the bar and of the subsequent formation of trailing spiral arms at the diametral-opposite ends of the bar. It is suggested that the $\theta$-shaped barred galaxies may be transient features appearing at a late stage of the evolution sequence. The maximum life-time of barred galaxies will lie between $1 \sim 4 \times 10^9$ years according to their size and the amount of gas passing through the bar per unit time. (auth)

**32876** GALACTIC STRUCTURE AND EXPLOSION OF THE GALACTIC NUCLEUS. Ishida, Keiichi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl. No. 31, 116-30(1964).

It can be considered that the 3-kpc arm expansion is caused by the explosion of the galactic nucleus. Because of a principle of angular momentum conservation, the expansion motion could not be a stationary phenomenon. The explosion must have happened $\sim 2 \times 10^7$ years ago. There are many observational evidences that indicate explosions of the galactic nucleus. One is the presence of the radio halo, and the next is the gas flow from the

halo into the galactic disk in the neighborhood of the sun. A brief discussion is presented to the generative force of the spiral structure in considering the stable configuration of a rotating system. (auth)

**32877** ON THE STABILITY OF THE SPIRAL ARMS. Amano, Tsuneo (Nagoya Univ., Japan); Sato, Masatomo; Terashima, Yoshinosuke. Progr. Theoret. Phys. (Kyoto), Suppl. No. 31, 131-55(1964).

The view point that the spiral arms could be in quasi-steady state is suggested from the considerations of instability. The dissipation of the magnetic field in the arms by instability is supposed to compensate the increase in the field due to the wrapping of the magnetic lines of force resulting from the differential rotation in the Galactic disk. These conclusions come from the fact that the possible mechanisms of instability have the growing times of the order of $10^8$ year, which is comparable to the characteristic time of the increase of the field. Taking into account the compressibility of fluid, the spiral arms are shown to be unstable for the interchange model of gravitational instability against a suitable length of deformation. For instance, its growing time (the e-folding time) is estimated about $10^8$ year for the length of perturbation of about 1 kiloparsec along arms. It follows from a rather specific model of the arms that they are also subject to the tearing mode of resistive instability having the growing time of $10^8$–$10^9$ year. A brief account of the intrinsic dissipation inside the arms is presented. Also the derivation of some formulas of gravitational instability and the discussions about the electric conductivity in the interstellar matter are appended. (auth)

**32878** POPULATIONS AND EVOLUTION OF STARS. Taketani, Mitsuo (Rikkyo Univ., Tokyo); Hatanaka, Takeo; Obi, Shinya. Progr. Theoret. Phys. (Kyoto), Suppl. No. 31, 156-61(1964).

A scheme was proposed for the whole evolutionary process of celestial objects and the observational characteristics between two populations, Populations I and II, are discussed in some detail. It is suggested that these characteristics can be accounted for by the present scheme. (auth)

**32879** THE GAMMA-RAY SPECTRUM OF THE SUN. Dolan, Joseph F. (Harvard Univ., Cambridge, Mass. and Inst. for Space Studies, New York); Fazio, G. G. Rev. Geophys., 3: 319-43(May 1964).

The $\gamma$-ray spectrum ($h\nu > 10$ kev) emitted by the sun is investigated and approximated fluxes at the earth are predicted on the basis of a simple solar-flare model. An attempt was also made to determine which part of spectrum is most feasibly detectable and which part yields the most direct information of solar-flare structure. Calculations were performed to evaluate the relative intensities and types of spectra produced for the following production mechanisms: synchrotron radiation; electron recombination with atoms (free-bound transitions); decay of naturally radioactive nuclei; inverse Compton effect; bremsstrahlung (free-free transitions); nucleon-nucleon reactions, including thermonuclear reactions; de-excitation of nuclei produced by nuclear bombardment, and $\pi^0$-meson decay; and electron-positron annihilation, including $\beta$ decay and $\pi^+$-meson decay. (L.B.S.)

**32880** RADIO EMISSIONS FROM THE PLANET JUPITER. McNally, D. (London Univ.). Sci. Progr. (London), 53: 257-62(Apr. 1965).

The radio emissions from Jupiter are described, and their interpretation in terms of a Jovian magnetosphere is briefly discussed. (auth)

**32881** QUASI-STELLAR SOURCES: VARIATION IN THE RADIO EMISSION OF 3C 273. Dent, W. A. (Univ. of Michigan, Ann Arbor). Science, 148: 1458-60(June 11, 1965).

Evidence is presented for the first time for large fractional variations in the radio emission of the quasi-stellar sources 3C 273, 3C 279, and 3C 345, all of which have flat radio spectra at centimeter wavelengths. (auth)

**32882** IO-RELATED RADIO EMISSION FROM JUPITER. Dulk, George A. (Univ. of Colorado, Boulder). Science, 148: 1085-9(June 18, 1965).

As evidenced by spectra of Jupiter's decametric radio emissions from 1960 through 1964, Jupiter's satellite Io acts to induce much of the emission and influence the spectral character of the emission. The emission pattern of Io-related emission is derived, and possible interaction mechanisms to explain the Io effect are discussed. (auth)

**32883** SECTOR STRUCTURE OF THE QUIET INTERPLANETARY MAGNETIC FIELD. Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.) and Wilcox, John M. Science, 148: 1592-3(June 18, 1965).

Observations of the interplanetary magnetic field by the Imp-1 satellite have revealed a regular longitudinal sector structure in this field. The sectors co-rotate with the sun; as an average sector sweeps past the earth, the magnitude of the interplanetary field decreases from more than 6 gammas (1 gamma = $10^{-5}$ gauss) to less than 4 gammas, and the daily sum of the geomagnetic activity index, $K_P$, decreases from 25 to less than 10. (auth)

**32884** COSMOGENIC RADIONUCLIDES IN THE BONDOC METEORITE. Cressy, Phillip J., Jr.; Shedlovsky, Julian P. (Carnegie Inst. of Tech., Pittsburgh). Science, 148: 1716-17(June 25, 1965).

Long-lived cosmogenic radionuclides were measured in the stone phase and in a mechanically separated metallic nodule from a fragment of the Bondoc mesosiderite. Activity levels of the various radionuclides in both phases, along with results of mass spectrometric measurements of rare gas isotopes in the stone phase, indicate that heavy shielding was the chief cause of the low specific activities observed. (auth)

## Atomic Physics

*Refer also to abstract 32853.*

**32885** (AD-610869) MEASUREMENTS OF ATMOSPHERIC ION REACTIONS. Yearly Technical Summary Report, August 1, 1963–July 31, 1964. Stebbings, R. F.; Fineman, M. A.; McGowan, J. W.; Turner, B. R.; van Lint, V. A. J.; Wyatt, M. E. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Jan. 25, 1965. Contract DA-49-146-XZ-041. 207p. (GA-5615; DASA-1573). $6.00(CFSTI).

Charge transfer and charged rearrangement collision cross sections were measured at energies down to 2 ev with identification of product ions and some state selection of primary ions. Electric impact studies of molecular oxygen with high resolution provided information on the ionization process, while investigations of negative ions in afterglows of atmospheric gases demonstrated the comparative lack of understanding in this aspect of atmospheric deionization. The following reactions were studied by the ionization afterglow technique: ionic recombination in $O_2$; thermalization diffusion and electron-ion dissociative recombination in $N_2$; attachment in gases containing $NO_2$; attachment and electron-ion dissociative recombination in gases containing NO. (auth)

**32886** (LAMS-3015) RADIATIVE AND CONDUCTIVE OPACITIES AND MONOCHROMATIC ABSORPTION COEFFICIENTS FOR COPPER. Stewart, John N.; Cox, Arthur N. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 1963. Contract W-7405-eng-36. 204p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

Tentative data on copper monochromatic absorption coefficients, radiative opacities, and conductive opacities are given for the temperature range of 0.1 to 2.0 kv and the density range $1 \times 10^{-3}$ to $3 \times 10^2$ g/cm$^3$. The data are based on the calculation of positions and occupation numbers of the bound levels, and on the use of equation-of-state data and absorption formulas. (D.L.C.)

**32887** CONTINUUM-SOURCE MOLECULAR BEAMS. French, J. Barry (Univ. of Toronto). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 993-1000(June 1965).

The feasibility and advantages of producing molecular beams from continuum sources are summarized. Although understanding of all aspects of the formation process is still incomplete, the advances made over the past three years have been remarkable. Many aspects of the expansion process of a free jet and the behavior of the Mach cell, even for extreme pressure ratios, have been investigated and clarified. It has been shown that the formation of a beam by skimming can be successfully accomplished, although the mode of operation of the skimmer in the interesting transition region is not completely understood. This is particularly true of the role of flow disturbances due to external shocks, internally reflected molecules, and self-scattering of the beam immediately after skimming in affecting final beam intensity and the separation of gas mixtures. The various beam parameters of beam designs and performances achieved to date are summarized briefly. Each of these various approaches has its own peculiar advantages and disadvantages and a variety of specialized forms of continuum-source beams will undoubtedly prove inevitable and desirable. The only certainty is that, with the capabilities and potential now proved, the immediate future will see these beams being applied to basic investigations of many gas-phase and surface phenomena not previously open to experiment. (auth)

**32888** BASIC CONCEPTS OF SELF-CONSISTENT-FIELD THEORY. Blinder, S. M. (Univ. of Michigan, Ann Arbor). Am. J. Phys., 33: 431-43(June 1965).

According to Hartree's self-consistent-field (SCF) model of the atom, the motion of each electron in the effective field of the N-1 others is governed by a one-particle Schroedinger equation. Self-consistency of the electronic charge distribution with its own electrostatic field leads to a set of coupled integrodifferential equations (Hartree equations) for N one-particle wave functions (atomic orbitals). The Hartree equations are subsequently shown to be precisely the conditions for optimization of an approximate wave function consisting of a product of atomic orbitals. An improved formalism, due to Slater and to Fock, represents the atomic wave function by a determinant built of atomic spin-orbitals and is thereby consistent with the Pauli principle. Application of the variational principle to a Slater determinant leads to a set of N coupled equations (Hartree-Fock equations), quite similar to Hartree's equations but containing, in addition, exchange interactions—an effect having no classical analog. The error inherent in the Hartree–Fock method, known as electron correlation, arises from smoothing out of interelectronic repulsive interactions into effective Coulomb and exchange potentials. It accounts for roughly a 1% error in the total energy but is magnified in energy differences, which are more directly related to experimental quantities. A significant improvement in computational facility is achieved if the orbital functions are expanded in terms of a finite set of basis functions. The integrodifferential equations are thereby transformed into algebraic equations (Roothaan's equations) for the expansion coefficients. The analytic approach makes it possible to apply the self-consistent-field method to molecular systems. To date, SCF calculations have been carried out, in some form, for all the atoms in the periodic table and for a growing list of diatomic and polyatomic molecules. (auth)

**32889** SCATTERING OF $H^+$ BY H. Fulton, Margaret J.; Mittleman, Marvin H. (Univ. of California, Livermore). Ann. Phys. (N. Y.), 33: 65-76(June 2, 1965). (UCRL-12251)

An attempt is made to describe the $H^+$ on H collision in the intermediate energy range where neither the high energy nor the low energy theories are expected to work. A wave function that gives good results at both high and low energies is used in a variational expression to obtain intermediate energy results. The problem is considered as a prototype of ion-parent atom collisions where in general molecular wave functions are not available. Hence only atomic wave functions are used throughout. Results are presented for exchange to the ground state, total exchange, total ionization, and total nonexchange excitation. An attempt is also made to describe Everhart's experiment. A damping of the resonances is obtained with some improvement over previous results. (auth)

**32890** COLLISION CROSS-SECTION STUDY OF $CO_2$. Lassettre, Edwin N.; Shiloff, Jerome C. (Ohio State Univ., Columbus). J. Chem. Phys., 43: 560-71(July 15, 1965).

Electron-collision cross section determinations, as a function of scattering angle, for carbon dioxide are described. A weak transition at 9-v excitation energy is of special interest. The shape of the peak changes markedly with angle. The theory of the effect is discussed in general terms. (auth)

**32891** MOMENTUM TRANSFER CROSS-SECTION THEOREM. Gerjuoy, E. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). J. Math. Phys. (N. Y.), 6: 993-6(June 1965).

The momentum transfer cross section is expressed in terms of a matrix element of grad V, where V is the potential which need not be spherically symmetric. The result may be useful for estimating the momentum transfer cross section in circumstances where the usual expansion in partial waves is inconvenient or inapplicable as, e.g., when V is noncentral. (auth)

**32892** ENERGY LEVEL AND LINE TABLES FOR ONE-ELECTRON ATOMIC SPECTRA. Garcia, J. D.; Mack, J. E. (Univ. of Wisconsin, Madison). J. Opt. Soc. Am., 55: 654-85(June 1965).

Tables are presented showing precise values of the energy levels and lines of the spectra $^1H_I$ to $^{40}Ca$ xx according to an equation expected to exhibit a relative uncertainty of the order of $10^{-11}Z^7$. Only one isotope per element is listed beyond $Li_{III}$. All levels are given up to n values ranging from 12 for $H_I$ to 4 for Ca xx and those of lowest and highest j up to n values ranging from 50 for $H_I$ to 8 for Ca xx. For each line complex with given n and n′, the wavenumbers of the two extreme lines and the statistical mean are given up to values ranging from n = 20, n′ = 12 for $^1H_I$ to n = 7, n′ = 6 for $^{40}Ca$ xx. (auth)

**32893** ELECTRIC FIELD IONIZATION PROBABILITIES FOR THE HYDROGEN ATOM. Bailey, D. S. (Univ. of California, Livermore); Hiskes, J. R.; and Riviere, A. C. Nucl. Fusion, 5: 41-6(Mar. 1965). (CLM-P-50)

The electric field ionization probabilities for the hydrogen atom, calculated by the methods of Lanczos and of Rice and Good, are presented graphically for the extreme components of all levels through n = 25 and for all the individual states belonging to a particular level through n = 7. Tabulations of the ionization probabilities are presented for a few representative levels. (auth)

**32894** ALTERNANT MOLECULAR ORBITAL METHOD FOR CYCLIC SYSTEMS OF NONCLOSED-SHELL STRUCTURE. Kwo, W. T. (Dow Chemical Co., Midland, Mich.). Phys. Letters, 16: 115-16(May 15, 1965).

Lowdin's formulation of the alternant molecular orbital method is extended to a cyclic system of nonclosed-shell structure consisting of 4n electrons moving in a framework of 4n protons each occupying a vertex of a regular polygon of 4n sides. The total wave function in the case of the lowest singlet state is given, from which the expectation value of the energy is determined. It is shown that omission of the contributions to the energy arising from the nonvanishing overlap integrals between alternant molecular orbitals leads to a different expression for the energy contributions from the non-closed-shell electrons, which leads to an incorrect asymptotic behavior for the total energy in the limit of large internuclear separation. (L.B.S.)

**32895** POLARIZATION OF THE He II LINE $\lambda = 4686$ Å IN ELECTRON–HELIUM ATOM COLLISIONS. Haidt, D.; Kleinpoppen, H.; Krueger, H. (Universitat, Tubingen, Ger.). Phys. Letters, 16: 122-3(May 15, 1965).

The 4686 Å hydrogen-like line of the single ionized helium ion was excited in an helium gas-filled tube by a parallel electron beam, and was separated from other lines by means of a monochromator. The radiation intensity po-

larized parallel and perpendicular to the electron beam direction was measured as a function of the electron energy. The polarization at the excitation threshold was found to be about 13%, which was obtained extrapolation of the almost linear increase to the threshold. The optical excitation function was also measured in the energy range from the threshold to 300 ev, and a flat maximum was observed at 200 ev. (L.B.S.)

**32896** DIRECT OBSERVATION OF QUANTUM BEATS DUE TO COHERENT EXCITATION OF NONDEGENERATE EXCITED STATES BY PULSED ELECTRON IMPACT. Hadeishi, Tetsuo; Nierenberg, William A. (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 891-2(May 31, 1965).

A description of modulation of exponential decay of resonance luminescence arising from the interference of coherently excited nondegenerate states $m_J = +1$ and $-1$ of $7^1P_1$ of Cd excited by a sharply pulsed electron impact is presented. (M.O.W.)

**32897** RESONANCE PHENOMENA IN THE SCATTERING OF ELECTRONS BY $H_2$ AND $D_2$. Golden, D. E.; Bandel, H. W. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev. Letters, 14: 1010-13(June 21, 1965).

A modified Ramsauer technique was used to observe electron-molecule resonance cross-section structures in $H_2$ and $D_2$. Values of the energy and changes in cross section at the resonances are reported for both $H_2$ and $D_2$. (M.O.W.)

**32898** LASER DOUBLE-QUANTUM PHOTODETACHMENT OF $I^-$. Hall, J. L.; Robinson, E. J.; Branscomb, L. M. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev. Letters, 14: 1013-16(June 21, 1965).

Results of an experimental study of two-quantum induced photodetachment of electrons from a beam of negative ions of atomic iodine ($I^-$) in high vacuum are presented. (M.O.W.)

**32899** RADIALLY OSCILLATING ELECTRON—THE BASIS OF THE CLASSICAL MODEL OF THE ATOM. Gryzinski, Michal (Inst. for Nuclear Research, Swierk, Poland). Phys. Rev. Letters, 14: 1059(June 28, 1965).

The concept of radially oscillating electrons is discussed. Two assumptions needed to explain previous experimental phenomena are in contradiction with the prevailing classical notions regarding the structure of the atom. These assumptions are shown to be acceptable using the concept of a radially oscillating electron. (M.O.W.)

**32900** POLARIZED ELECTRONS FROM A POLARIZED ATOMIC BEAM. Long, R. L. Jr.; Raith, W.; Hughes, V. W. (Yale Univ., New Haven). Phys. Rev. Letters, 15: 1-4(July 5, 1965).

The successful production of polarized electrons by photoionization of a polarized atomic beam of alkali atoms is reported. The experimental procedure is outlined. (M.O.W.)

**32901** LAMB SHIFT IN $(Li^6)^{++}$. Fan, C. Y.; Garcia-Munoz, M.; Sellin, I. A. (Univ. of Chicago). Phys. Rev. Letters, 15: 15-17(July 5, 1965).

Production of a sufficient number of $^6Li^{2+}$ ions in the 2s state to make a measurement of the Lamb shift in $^6Li^{2+}$ possible is reported. The experimental procedure is given and results agree within about 1% of that obtained previously. (M.O.W.)

**32902** ELECTRON CORRELATIONS IN NARROW ENERGY BANDS. [PART] IV. THE ATOMIC REPRESENTATION. Hubbard, J. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc (London), Ser. A, 285: 542-60(May 11, 1965).

A reformulation and extension of the previous theory is described. The new formulation has the advantage of being conceptually simpler than the earlier theory; it can, in fact, be developed in close analogy with the usual theory of spin waves. It is shown that the simplest approximations in the new formulation lead to theories of the crystal field, the Weiss molecular field, spin waves, polarization waves and the quasi-electron theory of the earlier papers of this series. The new formulation permits one to take into account the interactions of electrons on different atoms and to consider solutions of the anti-ferromagnetic and more complicated kinds. The theory is developed by the equation of motion method. (auth)

**32903** A NEW METHOD FOR STUDYING THE ATOM. Stanley Bashkin (Univ. of Arizona, Tucson). Science, 148: 1047-53(May 21, 1965).

A method for producing optical spectra for multiply ionized atoms by particle accelerators is discussed, and experiments conducted by the High Voltage Engineering Corporation and the Naval Research Laboratory are described. The method offers a means for better temperature determinations in hot plasmas, assisting in the quantitative assignment of element abundance in the stars, and spectral determinations of the solar corona. The possibility of studying every stage of ionization for every element in the periodic table is provided. (L.B.S.)

**32904** INELASTIC COLLISIONS IN QUASI-CLASSICAL APPROXIMATION. Presnyakov, L. P. Tr. Fiz. Inst., Akad. Nauk SSSR, 30: 236-52(1964). (In Russian)

The quasi-classical approximation or parametric method is used to calculate the effective collision cross section of atoms in events involving heavy particles, such as atoms or ions; it may be also used in the case of collision with electrons. Within the framework of the quasiclassical method, the coordinates of the relative position of the colliding systems R are considered as the time function R(t), describing an atom within the alternating field of the perturbed particles by the nonstationary Schroedinger equation. The approximate solution of the two-equation system yields results which agree well with those derived by other approximation methods, such as those elaborated by Landau and Lifshits, and Demkov and Dykhne, which do not refer to the perturbation theory. In order to simplify the calculations, a two-level approximation is used at the start, calculating the transition probability and the cross section. (TTT)

**32905** INVESTIGATION OF THE REFLECTION OF POTASSIUM, RUBIDIUM AND CESIUM ATOMIC BEAMS FROM A QUARTZ PLATE. Myasnikov, L. L.; Raigorodskii, L. D.; Finagin, B. A. (Shipbuildfng Inst., Leningrad). Zh. Tekhn. Fiz., 35: 542-5(Mar. 1965). (In Russian)

The reflection of K, Rb, and Cs atoms from the polished surface of an X-cut quartz crystal was investigated. The atomic beams were formed in a constant temperature oven containing the alkali metal in the liquid state and provided with a collimating channel, and the reflected atoms were detected by surface ionization on the tungsten strip. The attitudes of the oven and detector relative to the quartz reflecting surface could be changed without breaking the vacuum. The quartz crystal could be heated, cooled, or excited to mechanical vibration at the resonant frequency of 980 kc. The most efficient specular reflection (reflection coefficient from 15 to 20%) was obtained at a grazing angle of 3°. When the quartz reflector was heated from room temperature to 340°K the reflected beam became considerably more diffuse. When the reflector was cooled to 230°K, two diffraction maxima appeared (with the K and Rb but not the Cs beams) at reflection grazing angles of approximately 9°. These diffraction maxima disappeared and the reflected beam became slightly more diffuse when the quartz reflector was excited to ultrasonic vibration (amplitude 0.4 micron). Calculations of the diffraction by a two-dimensional grating representing the quartz crystal surface of atoms having de Broglie wavelengths corresponding to the 400°K oven temperature gave results that were not in agreement with the observed positions of the diffraction maxima. It is suggested that diffraction by the surface layer at small grazing angles may represent a case intermediate between Bragg scattering and diffraction by a two-dimensional grating. (ATD)

**32906** ELECTRON-MOLECULE AND PHOTON-MOLECULE COLLISIONS. Morrison, J. D. (Common-

wealth Scientific and Industrial Research Organization, Melbourne). p.397-466 of "Energy Transfer in Gases." New York, Interscience Publishers, [1963].

A review on the investigation of the excitation, ionization, and dissociation of molecules by electron and photon impact is presented, with consideration of experimental methods and equipment and of interpretation of the data. Some experimental results, notably ionization efficiency curves, are discussed in relation to theory. 97 references. (D.C.W.)

# Cosmic Radiation

**See also Elementary Particles and Radiations. Nuclear Properties and Reactions.**

*Refer also to abstracts 32858, 32867, and 33064.*

**32907** (AD-608028) IONIZING RADIATION DETECTED BY PIONEER II. Rosen, Alan; Coleman, Paul J. Jr.; Sonett, C. P. (Space Technology Labs., Inc., Los Angeles, Calif.). May 6, 1959. 8p. $1.00(CFSTI).

The total ionizing component of cosmic radiation was measured to an altitude of 1550 km. An upper bound to the ratio of average-to-minimum specific ionization was determined by comparing the ionization with the count-rate observations from the Explorer IV satellite. This result implies that protons are the predominant specie which gave rise to the observed ionization. (auth)

**32908** (BNL-9119) SOLAR NEUTRINO DETECTION BY THE $Cl^{37}-Ar^{37}$ METHOD. Davis, Raymond, Jr.; Harmer, Don S. (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 17p. (CONF-650111-4). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From CERN Informal Neutrino Conference, Geneva.

A neutrino detection system is developed that is based on the reaction $^{37}Cl(\nu,e^-)^{37}Ar$, in a 3800-liter tank of perchloroethylene buried 2300 feet deep in a limestone mine. After several months of exposure to neutrinos, the Ar is removed from the tank by purging, and the $^{37}Ar$ activity is measured. No $^{37}Ar$ activity is found, so it is concluded that the solar neutrino reaction rate is less than or equal to $16 \times 10^{-35}$ $sec^{-1}$. Calculations based on $^7Be$ and $^8Be$ indicate that the solar neutrino reaction rate with $^{37}Cl$ should be on the order of $(3 \pm 2) \times 10^{-35}$ $sec^{-1}$. Thus the sensitivity of the equipment used is a factor of about five below that required to detect the calculated solar neutrino flux. (T.F.H.)

**32909** FREQUENCY SPECTRA OF DISCRETE SOURCES IN THE DECAMETRE RADIOWAVE BAND. Bazelyan, L. L.; Braude, S. Y.; Krymkin, V. V.; Men, A. V.; Sodin, L. G. (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 5, 580-3(1965). (In Ukrainian)

A wide-band radiotelescope was used to measure the radiation flux of six discrete sources of cosmic radiation over a frequency range of 20 to 40 Mc/s. It was concluded that for the investigated discrete sources, the location of which is bounded by the galactic coordinates: $21° \leq l^{II} \leq 89°$, $-13° \leq b^{II} \ll 60°$, there are no turning points of the frequency spectrum in the given frequency range. (auth)

**32910** NEUTRON MONITOR MASS ABSORPTION COEFFICIENTS AT CHICAGO AND CLIMAX DURING SOLAR CYCLE 19 (1954-1963). Forman, Miriam A. (Univ. of Chicago). J. Geophys. Res., 70: 2469-73(June 1, 1965).

The dependence of the neutron monitor mass absorption coefficient on 11-yr changes in the primary cosmic-ray spectrum was investigated for the monitors at Chicago, Illinois, and Climax, Colorado, using a modified single regression method. The analysis of hourly intensity and pressure values for 733 days at Chicago and 1000 days at Climax during the period 1954-1963 revealed no significant variation at either station. The mean value of the coefficient is $-0.938 \pm 0.007$ and $-1.010 \pm 0.006$%/mm Hg at Chicago and Climax, respectively. This difference depends on the altitude characteristics of the nucleonic component. These results are compared with previous results. (auth)

**32911** ON THE PROPAGATION AND DIFFUSION OF SOLAR PROTONS. Fibich, Moshe; Abraham, Phillip B. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 70: 2475-84(June 1, 1965).

A diffusion model for the propagation of solar flare particles in interplanetary space is adopted. The irregularities in the magnetic field are assumed to act as a uniform distribution of scattering centers, and the regular part of the interplanetary field is taken to be either radial or homogeneous. A modified diffusion equation, involving a diffusion tensor, is considered. The resulting density is a function of the location of the flare on the surface of the sun. Under the same assumptions, a more rigorous approach is proposed through use of the Boltzmann equation. The solutions obtained suggest that the regular magnetic field leads to a transition (during the initial phase of the event) from a one-dimensional to a three-dimensional diffusion regime. (auth)

**32912** OBSERVATION OF THE COSMIC RAY ELECTRON-POSITRON RATIO FROM 100 Mev TO 3 Bev IN 1964. Hartman, R. C.; Meyer, Peter; Hildebrand, R. H. (Univ. of Chicago). J. Geophys. Res., 70: 2713-15(June 1, 1965).

An experiment in which the electron-positron ratio in cosmic radiation was measured in a balloon flight from Ft. Churchill on July 16, 1964, is summarized. The results show that the electron excess, which was previously observed in the energy interval from 0.1 to 1.0 Bev, extends to at least 3.0 Bev, showing that accelerative processes are the dominant source of primary electrons even at higher energies. (D.C.W.)

**32913** FERMI ACCELERATION OF SOLAR COSMIC RAYS. Wentzel, Donat G. (Univ. of Michigan, Ann Arbor). J. Geophys. Res., 70: 2716-19(June 1, 1965).

The Fermi acceleration of particles is discussed, with particular consideration of the resulting particle spectrum. It is noted that several energy-or rigidity-dependent spectra can be generated by the Fermi mechanism, the spectral shape depending on the manner of escape from the region of acceleration. (D.C.W.)

**32914** DIFFRACTION DISSOCIATION: A POSSIBLE INTERPRETATION OF HIGH ENERGY "ONE CONE" JETS. Bozoki, G.; Gombosi, E.; Nagy, E. (Central Research Inst., of Physics, Budapest). Phys. Letters, 17: 65-7 (June 15, 1965).

Previous investigations of high energy nuclear interaction of cosmic ray particles showed that in certain cases the produced particles are emitted in one cone only in the laboratory system. These anomalous jets were interpreted in the frame of the two center model, by isotropic particle emission from one center moving in the direction of the primary particle. It is now shown that the characteristics of a large fraction of anomalous jets can also be explained by diffraction or Coulomb dissociation of nuclear active cosmic ray particles in the nuclear field of nuclei. (J.F.P.)

**32915** A STUDY OF THE PROPAGATION OF SOLAR PARTICLES IN INTERPLANETARY SPACE. THE CENTER-LIMB EFFECT OF THE MAGNITUDE OF COSMIC-RAY STORMS AND OF GEOMAGNETIC STORMS. Yoshida, S.; Akasofu, S.-I. (Univ. of Alaska, College). Planetary Space Sci., 13: 435-48(May 1965).

The magnitude of cosmic-ray storms (the Forbush decrease) and of geomagnetic storms (expressed by the $K_p$ and $D_{st}$) is examined as a function of central meridian distance of the corresponding solar flares. The storms are grouped according to the characteristics of the preceding energetic solar particle events. It is shown that a remarkable "center-limb" effect in the magnitude of the storms can be recognized only if such a grouping is made. Taking this effect into account, it is demonstrated that

solar flares associated with an unusual cosmic-ray increase are the most energetic throughout the entire range of the energy spectrum of solar particles, releasing the largest amount of energy for cosmic-ray storms and magnetic storms. The significance of the results is discussed in detail. (auth)

**32916** STUDY OF RADIATIONS DURING THE FLIGHTS OF INTERPLANETARY AUTOMATIC STATIONS MARS-1 AND LUNA-4. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; Gorchakov, E. V.; Logachev, Yu. I.; Lyubimov, G. P.; Nikolaev, A. G. Planetary Space Sci., 13: 461-8(May 1965).

Translated by H. S. H. Massey from Kosmich. Issled., Akad. Nauk SSSR, 2: No. 4, p.633(1964).

A brief description is given of the apparatus in the Mars-1 and Luna-4 stations for recording radiations, and the results obtained are discussed. It is found that up to a distance of 0.24 astronomical units from the Earth, the intensity of the cosmic radiation remains practically the same. Data are also given on the cosmic-ray intensity at different periods of the solar activity cycle. During the flight of Luna-4 slow smooth variations in the cosmic-ray intensity were recorded; these are connected with the variation of the magnetic state of the solar system. During its flight away from the Earth, Mars-1 passed through the Van Allen belts; data are given on these. (auth)

**32917** MODULATION OF GALACTIC COSMIC RADIATION IN INTERPLANETARY SPACE BY THE SOLAR WIND. Apparao, Krishna; Ramadurai, S. (Tata Inst. of Fundamental Research, Colaba, India). Proc. Indian Acad. Sci., Sect. A, 61: 237-54(Apr. 1965).

The effect of the solar wind on the relative abundances of galactic cosmic rays is assessed using the theories proposed by Parker and Dorman. The modulation factors for the ratios of electrons, deuterons, tritons, and helium nuclei to protons, helium-3 to helium-4 and light ($Z = 3-5$) to medium nuclei ($Z = 6-9$) are presented. The effect of the modulation on the differential energy spectra is studied. The form of the spectra, the position of the maximum in the spectra, and the relative reduction over a solar cycle place a restriction on the parameters in the solar wind theory. Starting with plausible galactic spectra and by varying the parameters, it is possible to fit the form of the solar minimum spectrum, but it does not seem possible to produce the relative reduction between minimum and maximum throughout the energy range, within the framework of the present solar wind theory. (auth)

**32918** ON COSMIC RAY J-INDEX AS A TRIAL TO REPRESENT DEGREE OF DISTURBANCE IN TIME VARIATIONS. Kodama, Masahiro; Wada, Masami (Inst. of Physical and Chemical Research, Tokyo). Rept. Ionosphere Space Res. Japan, 17: 115-36(June 1963).

A tentative cosmic ray index, J-index, which quantitatively indicates the degree of disturbances in time variations of cosmic ray intensity, is proposed. J-index represents time variations caused by some modulations in the interplanetary space, which as diurnal variation, Forbush decrease and others up to a period of 27 days, where a phenomenon of the so-called unusual increase is excluded. Values of J-index calculated from neutron data obtained at three cosmic ray stations for U. T. days during July 1957 to December 1961 are presented. Results of some statistical analyses by use of J-index are described, showing that they may be of use for investigators having interests in cosmic ray time variations. (auth)

**32919** ON THE SPACE DISTRIBUTION OF MUON FLUX IN EXTENSIVE AIR SHOWERS. Khrenov, B. A. (Moscow State Univ.). Yadern. Fiz., 1: 540-6(Mar. 1965). (In Russian)

The pion generation function in EAS is found as a function of atmospheric depth, using experimental data on the spatial distribution of muon flux in EAS and on the distribution of transverse pion momenta in nuclear interactions. The very simple case of fluctuations of the pion generation function and of the corresponding fluctuations of the spatial distribution function of muon flux in EAS is considered. (auth)

**32920** THE EXTENSION OF SOME EXPERIMENTAL RESULTS OF COSMIC RAY PHYSICS TO NUCLEAR PHYSICS. Pinkau, K. Thesis, Kiel, Universitat, 1963. 75p. (In German). $2.00(Gmelin, AED-DISS. 63-749).

A cascade theory, which describes spectra of secondary particles, is given. Agreement between various experimental results can be obtained by the extrapolation to high energies of production spectra measured with accelerators. Air cascades can also be treated by cascade theory. (Gmelin Inst.)

## Direct Energy Conversion

**32921** (AD-610151) RESEARCH PROGRAM ON APPLICATION OF JET COMPRESSOR TO MAGNETOPLASMADYNAMIC ELECTRICAL POWER GENERATION. Final Report, June 1, 1963–November 30, 1964. (Martin-Marietta Corp., Baltimore, Md. Aerospace Div.). 47p. (MND-3176). $2.00(CFSTI).

The objectives were to analyze a closed-cycle jet compressor in which the waste thermal energy from an MPD system is transferred to a primary jet stream which compresses the MPD generator working medium, and to develop a single-stage jet compressor. An IBM computer program was developed to study the performance of jet compressors with one stage and two stages; the results indicate a possible pressure rise of 47% for one-stage operation and 97% for two-stage operation. An experimental single-stage jet compressor was developed, and its components and instrumentation are described. Two experimental runs were made, and the results were analyzed; they establish the feasibility of using a high-molecular-weight metal vapor to compress a low-molecular-weight gas. (D.L.C.)

**32922** (AD-610176) PERFORMANCE AND FLUID FLOW CHARACTERISTICS OF AN ELECTRO-FLUID DYNAMIC GENERATOR (thesis). Roland, Jay Roy (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Aug. 1964. 106p. (GA/ME/64-5). $4.00(CFSTI).

An investigation was conducted on performance and fluid flow characteristics of an EFD (electro-fluid dynamic) generator in order to experimentally determine the performance of an EFD generator using two different ground plate inserts under various conditions. The generator consisted of a closed loop pressurized system with an ejector powered secondary flow. An ion production system produced a locally intense electric field which partially ionized a high velocity neutral gas. The ions were carried through a conversion duct against a potential gradient, and were then collected and neutralized. Because the electric field from the collector opposed the motion of the ions, fluid dynamic energy was converted into electrical energy. In Phase I of this study, four configurations were tested under various conditions in order to determine the best geometric configuration, to check needle currents, and to measure performance. In Phase II, a modified conversion duct was used to measure total pressure profiles and static pressure at four stations along the duct. Results showed that the normal ground plate insert gave better performance because of higher needle currents, and that the primary to secondary pressure ratio of three did not yield maximum needle current, as a pressure ratio of four gave a definite increase. (auth)

**32923** (AED-C-15-05) DIRECT CONVERSION OF NUCLEAR ENERGY INTO ELECTRIC ENERGY. Series C: Bibliographies. (Battelle Institut e. V., Frankfurt am Main (West Germany)). Oct. 1965. 89p. Dep.(mn).

A total of 282 references is presented on the following subjects: thermionic converters, thermoelectric converters, magnetohydrodynamic converters, photoelectric converters, and energy conversion by other principles. The references are arranged into reports, conferences, journal articles, books, and patents. Author, report, patent, and subject indexes are included. (D.L.C.)

**32924** (ANL-7020(p.198-225)) ENERGY CONVERSION. (Argonne National Lab., Ill.).

The development of regenerative bimetallic and hydride cells is described. The emf-temperature characteristics of Li–Sn cells were determined. The solubilities of alkali metal and intermetallic species in molten salt electrolytes were studied. The thermodynamic behavior of several lithium hydride–halide systems was calculated from solid-liquid equilibrium data. The vaporization of Bi–Na in the regeneration of the Na–Bi cell was studied. Engineering studies of regenerative cells included operation of Na–Bi cells, material corrosion studies, and regeneration efficiency computations. (D.L.C.)

**32925** (BNL-8187) EFFECT OF INCLINATION ON RADIANT HEAT TRANSFER THROUGH AN APERTURE WITH RERADIATIVE WALLS. Hsu, Chia-Jung (Brookhaven National Lab., Upton, N. Y.). Jan. 1964. Contract AT(30-2)-Gen-16. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The prediction of total radiative heat flux through an aperture having inclined and reradiative walls has an application to the design of heat shields for a thermionic energy converter. In such a converter, the diffusive radiative heat flux is intercepted by the heat shields, while the electrons from the cathode are channeled through the spacing between the shields by magnetic force. Calculations are made for the case of a black-body aperture with the cross section of a very long rectangular slot. (D.L.C.)

**32926** (CEA-Bib-55) LES DIODES A PLASMA (theses). (Plasma Diodes (thesis)). Gondrand, Jean-Claude (Commissariat à l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucléaires). Apr. 1965. 19p. Dep.(mn).

Presented are the possibilities offered by plasma diodes. In the first part, a study is made of the theoretical efficiency of such a convertor without taking into account the losses, apart from the electronic cooling. The exact expression for this efficiency is then calculated by adding the losses due to the power radiated in the direction of the anode, to the fall in the ohmic voltage and to the thermal conduction of the cathode conductor. By optimization, the value of the efficiency for a given temperature is provided by a transcendental equation. It is shown in part two how the physical problems have been resolved: elimination of the space charge, choice of materials for the anode and cathode, use of a moderate temperature chain fitted with thermo-elements. (auth)

**32927** A CYCLIC ANALYSIS OF THE GABOR-TYPE AUXILIARY DISCHARGE THERMIONIC CONVERTER. Fouad, A. A.; Walsh, E. M. (Iowa State Univ., Ames). Advan. Energy Conversion, 5: 71-81(May 1965).

A cyclic analysis of a Gabor-type auxiliary discharge thermionic energy converter is presented. An overall charge balance for the system is believed to be the key in understanding the behavior of the ions and hence the converter performance. The analysis takes into account the phenomenon discovered by Gabor of the reflection of slow ions at the electrodes. A so-called critical equation is developed and discussed. The parameters in this equation can be determined from few measurements and data available in the literature. A sample calculation is presented to give an order of magnitude of the parameters involved and their relative importance. (auth)

**32928** ELECTRODE DROPS AND CURRENT DISTRIBUTIONS IN AN MGD CHANNEL. Karkosak, John J. (United Aircraft, Inc., East Hartford, Conn.); Hoffman, Myron A. AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1198-1200(June 1965).

The initial results of an experimental investigation on the influence of a continuous electrode geometry on the performance of MGD generators and accelerators are presented. (W.L.G.)

**32929** THE MHD PRESSURE JET TUBE PROJECT. Radebold, R.; Lang, H. (AEG Forschungsinstitut, Frankfurt am Main). Atomwirtschaft, 10: 243-6(May 1965). (In German)

The MHD pressure jet tube project which is being developed represents a German parallel to the American conversion assemblies SNAP-8 and SNAP-50. In contradistinction to the two above-mentioned SNAP reactors the MHD project provides for the direct conversion of fission heat into electrical energy. The pressure jet tube whose nuclear heat source is a metal cooled reactor consists of a single circulatory system which is complete in itself. The main requirements on the assembly are a reliability as high as possible, a suitable volume, an efficiency as high as possible and a high power to weight ratio. An essential difference between the MHD project and the SNAP-8 lies in the substitution of a magnetohydrodynamic convertor for the electromechanical convertor. In this way difficulties inherent in the steam turbine method, e.g., problems of liquid-gas phase separation, steam tightness and bearing lubrication, are no longer valid. Since only a single circulatory system is involved the MHD converter has, moreover, a very high power density as compared with a turbogenerator and a favorable power to weight ratio may therefore be expected for it. The construction of the pressure tube and the MHD process, which is closely allied to the MPD (magnetoplasmadynamic) technique, are discussed in detail. (auth)

**32930** DIRECT CONVERSION OF ENERGY. Euler, J. (Universitat, Gissen, Ger.). Brennstoff-Waerme-Kraft, 17: 139-42(Mar. 1965). (In German)

The papers presented at Lausanne on the direct conversion of energy could be classified with respect to the conversion device into galvanic fuel cells, MHD generators, thermionic converters, and superconducting cables. The most important data given on the four types of devices are presented. (J.S.R.)

**32931** NEW MHD POWER GENERATOR. Spaceflight, 7: No. 1, 28-9; 34(Jan. 1965).

Temperature differences of MHD power generators and nuclear reactors have previously kept them from operating together as a single power generator. The MHD generator previously required temperatures of the order of 5000°F whereas a recent experimental reactor was able to operate at 2200°F. Using the nonequilibrium ionization method, which is described operating temperatures of the MHD generator may be lowered to 2900°F. (M.O.W.)

**32932** THERMIONIC ENERGY CONVERTER. Gabor, Dennis; Engelberger, Joseph Frederick. British Patent 994,229. June 2, 1965. Filed Jan. 4, 1963.

An arrangement is provided for generating an alternating current in which one or more thermionic energy converters of the type having the main discharge controlled by an auxiliary discharge have their outputs switched to flow along two circuital paths in alternating sequence. The switched outputs energize an a-c power output winding in opposite directions alternately. The switching provided by a mechanical commutator acting as a two way switch or a solid state circuit providing the equivalent switching arrangement takes place during momentary interruption of the main discharge by corresponding momentary interruption of the auxiliary discharge. The operating converter continues to be utilized during both half cycles of alternating current output. The main current through the converter is in the form of a pulsating or periodically interrupted direct current and switching takes place during the short interval when the main current is zero. Interruption of the auxiliary current can be obtained by applying a small proportion of the alternating output power to control the auxiliary discharge. The converter may be provided with a single auxiliary anode energized by an unsmoothed full-wave rectified voltage derived from a circuit tuned to the frequency of the output transformer or with a pair of auxiliary anodes energized in push-pull from a winding on the output transformer so that the auxiliary discharge is switched from one anode to the other. (B.L.M.)

**32933** MAGNETOHYDRODYNAMIC GENERATOR. Beckwith, Sterling; Smith, Don B. U. S. Patent 3,162,781. Dec. 22, 1964. Filed Mar. 22, 1961.

A magnetohydrodynamic generator is described in which the combustion zone is formed of consumable carbon to

form the primary fuel for burning. Means are provided for preheating the fuel and air or fuel-air mixture prior to combustion. A plurality of adjacent and generally parallel carbon passages are provided for directing the combustible gas through the preheat zone, combustion zone, and to the magnetic field where the ionized gas passing through the field produces a d-c or a-c voltage at the electrodes positioned in the field. Exhaust gas from the combustion zone flows in a direction opposite to the conducting gas so that the exhaust from one passage is effective to preheat the gas in the adjacent passage. Introducing at least a portion of the combustion products into the combustible gas prior to burning increases the mass flow of combustible gas without increasing the Btu output of the generator. (B.L.M.)

**32934** MAGNETOHYDRODYNAMIC GENERATOR. Rosa, Richard J. (to Avco Corp.). U. S. Patent 3,182,213. May 4, 1965. Filed June 1, 1961.

An electrode system and a switching means in combination with a MHD generator provide a means for controlling the output of the generator or for producing an alternating current in the generator. Opposed electrodes are provided within the duct of the MHD generator and are aligned perpendicular to the magnetic flux and the direction of plasma flow. Each of the electrodes includes discrete segments by which conduction current flows between the segments to establish a Hall potential within the plasma in the direction of flow. A source of potential and means for connecting the potential in series across at least a selected portion of the Hall potential helps to reduce the conduction current within a selected portion to about zero. A second circuit interrupting means is connected in series with selected pairs of opposed electrodes. The connection of the source of potential and the circuit interrupting means are actuated in timed relationship. (B.L.M.)

**32935** ELECTRIC GENERATION. Hurwitz, Henry, Jr. (General Electric Co.). U. S. Patent 3,183,379. May 11, 1965. Filed Oct. 6, 1960.

A magnetohydrodynamic generator is described that is suitable of use in an open cycle type power plant. The MHD generator includes at least two rings of magnetic material displaced axially with respect to each other to form a channel between opposing surfaces. The rings have a layer of insulating material on the opposing surfaces. A magnetic field with lines of flux parallel to the axis of the rings is provided. An ionized fluid flows radially inwardly or outwardly between the rings transverse to the lines of flux creating a potential in the fluid between the fluid entering and leaving the channel. Means are provided for electrically connecting the potential to a load. To increase the output power of the generator several rings may be stacked in the axial direction to provide a plurality of channels. (B.L.M.)

**32936** ELECTRODE STRUCTURE FOR MAGNETOHYDRODYNAMIC DEVICE. Hurwitz, Henry, Jr.; Sutton, George W. (to General Electric Co.). U. S. Patent 3,183,380. May 11, 1965. Filed June 2, 1961.

An electrode structure for a MHD generator is described in which the current does not tend to concentrate at one edge of the electrode and does not substantially impede the flow of conducting gas. A plurality of pairs of electrodes are spaced along the flow path, are inclined at an angle to the flow path, and present a projected area facing the flow path. Each pair of electrodes are insulated from the remaining pairs. Passageways through the electrodes minimize the impedance to the flow of conducting fluid. (B.L.M.)

# Elementary Particles and Radiations

*Refer also to abstracts 33314, 33345, and 33387.*

**32937** (CALT-68-36) APPROXIMATE SYMMETRY AND THE ALGEBRA OF CURRENT COMPONENTS. Roger F. Dashen and Murray Gell-Mann (California Inst. of Tech., Pasadena). May 1965. Contract AT(11-1)-68. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A probability-conserving theoretical analysis of the approximate symmetries of hadrons is presented, including the generalization of U(6) symmetry and its application to moving hadrons. (T.F.H.)

**32938** (CALT-68-38) SERIES OF HADRON ENERGY LEVELS AS REPRESENTATIONS OF NON-COMPACT GROUPS. Dothan, Yossef; Gell-Mann, Murray; Ne'eman, Yuval (California Inst. of Tech., Pasadena). May 1965. Contract AT(11-1)-68. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Consideration is given to the use of a non-compact algebra that preserves the state of rest for each hadron level (stable or unstable), and approximately connects together the members of an idealized infinite sequence of such levels. Several schemes are discussed for the use of such algebras. (T.F.H.)

**32939** (IC/65/55) DYNAMICAL INTERPRETATION OF SPURIONS. Nishijima, K.; Saffouri, M. H. (International Centre for Theoretical Physics, Trieste (Italy)). May 1965. 24p. Dep.(mn).

The concept of spurions was introduced originally as a formal mathematical tool to express the selection rule $|\Delta I| = 1/2$ in the nonleptonic decay of strange particles. It is shown that spurions are of a deeper physical significance in that they can be used not only to express but also to derive selection rules in weak interactions. (auth)

**32940** (IC/65/56) UNITARY REPRESENTATIONS AND RELATIVISTIC COUPLING COEFFICIENTS FOR SL(2,C). Bisiacchi, G.; Fronsdal, C. (International Centre for Theoretical Physics, Trieste (Italy)). May 1965. 20p. (Dep.(mn).

Representations of SL(2C) are studied with a view to developing the requisite group theoretical methods. A short derivation of the unitary representations of SL(2C) is given. Some SL(2C) coupling coefficients are calculated. It is explained how the unitary irreducible representations of SL(2C) are related to the ordinary concept of spin, and it is shown how an invariant vertex function can be expressed in terms of physical states. As an illustration a vertex that includes the P-wave decay of a spin-1 particle into two spin-0 particles is calculated, an important result concerning the classification of the $\rho$-meson is derived. (auth)

**32941** (JINR-E-2156) SU(4) AND SU(6) SYMMETRIES AND BARYON-BARYON COLLISIONS. Bilenkii, S. M.; Kazarinov, Yu. M.; Lapidus, L. I.; Ryndin, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 11p. Dep.(mn).

SU(4) and SU(6) symmetries are applied to the collisions of baryons with baryons in the S-state and to the total cross sections of baryon-baryon interactions. The predictions of SU(4) symmetry for the S-wave of nucleon-nucleon scattering do not contradict the experimental data at energies of several hundreds of Mev. (auth)

**32942** (JINR-P-2065) ISSLEDOVANIE RASPADOV $K_2^0$-MEZONOV. (An Investigation of $K_2^0$ Decays). Anikina, M.; Vardenga, G.; Zhurovleva, M.; et al. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy; Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; and Akademiya Nauk Gruzinoskoi SSR. Institut Fiziki). 1965. 25p. Dep.(mn).

1082 decays of $K_2^0$ mesons detected in a magnetic cloud chamber were analyzed. The relative probability of the decay was found to be $W(K_{3\pi}) = 0.194 \pm 0.023$. The data on the lepton decay rule out the S-variant of the interaction. These data are in good agreement with the V-variant. On the basis of 267 $K_{3\pi} \to \pi^+\pi^-\pi^0$ decays an analysis was made of the distribution of the kinetic $\pi^0$ energy ($T_0$) which diverges noticeably with the phase curve ($\Phi$). In the linear approximation: $[dW(T_0)/d\Phi] = 1 + [\alpha(T_0)/M_0]$ the value for the coefficient $\alpha$ was found to be $a = -8.2^{+1.7}_{-1.3}$; that is in good agreement with $|\Delta I| = 1/2$. Under the assumption about

the possible existence of the 6-dipion resonance of Brown and Zinger the values for the mass and the width are obtained to be $M_\epsilon$ =(350 ± 10) Mev and $\Gamma_\epsilon$ = (75 ± 15) Mev. (auth)

**32943** (JINR-P-2067) FORMFAKTORY I KONSTANTY VZAIMODEISTVIYA DLYA 56-PLETA GRUPPY SL(6). (Form Factors and Interaction Constants for 56-Plet of the Group SL(6)). van Hieu, Nguyen; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 14p. Dep.(mn).

Relations between the form factors in the theory of SL(6) symmetry are obtained. (auth)

**32944** (JINR-P-2073) LOGARIFMICHESKII POTENTSIAL (b/x $^2$ln x) V TEORII g$\phi^4$. (A Logarithmic Potential (b/x $^2$ln x) in the Theory of g$\phi^4$). Tabachenko, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 8p. Dep.(mn).

The analytic properties of the scattering amplitude as a function of the coupling constant g and the angular momentum $\lambda$ are treated in the theory g$\phi^4$. It is found that for the potential (b/x $^2$ln x) the amplitude is analytic in g at the point g = 0 and has a logarithmic branch point at $\lambda$ = 0. (auth)

**32945** (JINR-P-2083) PELTONNYE RASPADY $K^0$-MEZONOV I VOZMOZHNOE NARUSHENIE CP-INVARIANTNOSTI. (Leptonic Decays of $K^0$ Mesons and a Possible Violation of CP-Invariance). Okonov, E.; Tsun-fan, Wu; Chuvalo, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1965. 10p. Dep.(mn).

The absolute probabilities and the time dependence of the leptonic decays of $K^0$ mesons are treated from the point of view of a possible experimental verification of CP invariance and the selection rule $\Delta Q = \Delta S$. It is shown that the appearance of oscillations in the time dependence of the total number of $K_1^0$ decays would imply a strong breakdown of the combined parity in this process (Sachs's hypothesis). (auth)

**32946** (JINR-P-2089) O RADIATSIONIYKH RASPADAKH VEKTORNYKH MEZONOV. (On Radiative Decays of Vector Mesons). Solov'ev, L. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 5p. Dep.(mn).

Radiative decays of vector mesons are treated in the framework of $SU_3$ and $SU_6$ symmetries. (auth)

**32947** (JINR-P-2090) OPREDELENIE OTNOSITEL'NYKH VEROYATNOSTEI RASPADOV $K_2^0 \to 3\pi$. (A Determination of Relative Probabilities of the $K_2^0 \to 3\pi$ Decays). Anikina, M.; Vardenga, G.; Zhuravleva, M.; Kotlyarevskii, D.; Nayagu, D.; Okonov, E.; Takhtamyshev, G.; Tsun-fan, Wu; Chkhaidze, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy; Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; and Akademiya Nauk Gruzinskoi SSR. Institut Fiziki). 1965. 10p. Dep.(mn).

Data on the relative probabilities of the $K_2^0 \to 3\pi^0$ decays were obtained, and an estimate is given for $K_2^0 \to \pi^+\pi^-\gamma$, finding $[W(K_2^0 \to 3\pi^0)/W(K_2^0 \to \text{charged particles})] = 0.28 \pm 0.08$, $[W(K_2^0 \to \pi^+\pi^-\pi^0)/W(K_2^0 \to \text{charged particles})] = 0.18 \pm 0.06$, and $[W(K_2^0 \to \pi^+\pi^-\gamma/W(K_2^0 \to \text{charged particles})] < 0.036$. The $K_2^0 \to 3\pi^0$ decay was detected by the Dalitz pair from $\pi^0$, and $K_2^0 \to \pi^+\pi^-\pi^0$, $\pi^0 \to \gamma e^+e^-$ by the four-prong events with $\pi^+\pi^-$ mesons and the Dalitz pair. The ratio $[\Gamma_2(3\pi)/\Gamma(3\pi)] = 1.19 \pm 0.23$ is in agreement with the selection rule $|\Delta I| = 1/2$. (auth)

**32948** (JINR-P-2107) ZAMECHANIE K ODNOI VOZMOZHNOSTI OB'EDINENIYA GRUPPY PUANKARE I GRUPPY VNUTRENNIKH SIMMETRII. (A Remark Concerning Uniting the Poincaré Group and Internal Symmetries). Kolomytsev, V. I.; Fakirov, D. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 9p. Dep.(mn).

A possibility of uniting the Poincaré group L and internal symmetries S is considered. The work is essentially a continuation of the ideas of Ottoson, Kihlberg, and Nisson. Nontrivial mass relations are obtained. (auth)

**32949** (LADC-6480) FORWARD SCATTERING. Baker, George A., Jr. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The forward scattering amplitude for meson–nucleon interactions is expanded about the elastic threshold in the relative momentum, in order to investigate the microscopic causality of these interactions. For $\pi$–N and K–N interactions, the results indicate non-causality. (T.F.H.)

**32950** THE BETHE-SALPETER EQUATION IN SYMMETRIC MESON THEORY. Kwiecinski, J.; Suranyi, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Polon., 27: 595-608(Apr. 1965).

A rearrangement of the terms of the perturbation theory is proposed. Three-particle vertices appear instead of the initial four-particle vertices. With the help of this rearrangement, it is shown that in any order of perturbation expansion of the kernel of the Bethe-Salpeter equation, the kernel satisfies the Fredholm condition. The asymptotic behavior of the leading Regge pole is found to be $\alpha(t) \sim (\log t)^{-1}$. (auth)

**32951** POTENTIAL SCATTERING OF A WAVE PACKET. Gettys, W. Edward (Clemson Univ., S. C.). Am. J. Phys., 33: 485-7(June 1965).

A wave-packet formalism is presented for obtaining the differential cross section for the elastic scattering of a single particle by a potential. The method avoids difficulties inherent in the more common formulations such as interference between incident and scattered waves, box normalization, and density of final states. The time sequence of events in the scattering process is pictured in an intuitively appealing manner. The initial form of the wave packet is specified explicitly, and the time development of the wave packet is determined from the time-translation operator. The asymptotic form of the wave packet is investigated after a sufficiently long time lapse, and the cross section is obtained from a calculation of particle flux densities. (auth)

**32952** CROSSING MATRICES FOR PARTICLES OF ARBITRARY ISOSPIN. Carruthers, Peter A.; Krisch, Jean P. (Cornell Univ., Ithaca, N. Y.). Ann. Phys. (N. Y.), 33: 1-14(June 2, 1965).

An elementary and systematic discussion is given of isospin crossing symmetry for "two-body" collisions involving particles of arbitrary isospins. Special attention is given to the question of phase relations among the states in the various crossed channels. Explicit formulas for the various crossing matrices are given in terms of Racah coefficients. Numerical forms are given for reactions of special interest. In an appendix the behavior of the relevant fields and operators under charge conjugation and G-conjugation is described. (auth)

**32953** BROKEN SYMMETRIES AND LEPTONIC WEAK INTERACTIONS. Oehme, Reinhard (Univ. of Chicago). Ann. Phys. (N. Y.), 33: 108-40(June 2, 1965).

The currents involved in lepton-lepton couplings generate the algebra of U(4). Corresponding U(4)-algebras can be constructed from the hadron currents; they may be considered as subalgebras of higher symmetries like U(6) × U(6), etc. The U(4)-algebras are used for the construction of two models of a universal weak coupling. One model is based upon the U(4)-algebra generated by the total hadron current involved in semileptonic interactions, and a second one is obtained by considering strangeness-changing and nonchanging currents separately. The first model involves the Cabibbo angle as a parameter and it requires this angle to be the same for all currents. The second model has no such parameter; it depends upon a possible larger manifestation of the symmetry breaking interactions to account for the damping of $\Delta S = 1$ transitions. In both cases the neutral generators of U(4) are identified with the $(1 + \gamma_5)$-projections of electromagnetic currents and of lepton number or triplet-number currents.

For triplets with charges z + 1, z, z, the first model gives preference to z = 0 and the second one to z = −1. The two models are discussed briefly in connection with the phenomenological situation and with the assumption of broken SU(3)-symmetry for the hadrons. Renormalization effects are considered in detail, especially in view of the damping factor required in the second model mentioned above. The commutation relations of the hadron currents, together with the hypothesis of partially conserved axial-vector currents, give a reasonable universal damping factor $\lambda_A \sim m_\pi/m_K$ for axial vector matrix elements. For vector currents one obtains an analogous result only under rather restrictive assumptions. Otherwise, commutation relations, partially conserved currents, and $\lambda_V \sim m_\pi/m_K$ are not consistent as long as other manifestations of the symmetry breaker are considered to be small. (auth)

**32954** ENERGY DISTRIBUTION OF BACKSCATTERED ELECTRONS. I. INSTRUMENTATION. Tabata, Tatsuo; Okabe, Shigeru (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 60-2(Mar. 1965).

The experimental arrangement to study the energy distribution of backscattered electrons is described. Primary electrons are provided by a 15-Mev linear accelerator. The scattering chamber, to which an analyzer magnet for scattered electrons is connected, permits a continuous variation of the angle of observation under vacuum. After passing through the analyzer magnet, scattered electrons are detected by measuring the d-c current from a plastic scintillator. The attainable energy resolution of the total arrangement is about 3%. (auth)

**32955** METHODS FOR MEASUREMENTS OF POLARIZATION OF ELECTRONS, POSITRONS, AND CIRCULARLY POLARIZED PHOTONS. Olsen, Haakon (National Bureau of Standards, Washington, D. C. and Norges Tekniske Hogskole, Trondheim, Norway). Arkiv Fys. Seminar Trondheim, No. 2, 20p. (1965).

The methods for measurements of polarization of electrons, positrons and circularly polarized photons are discussed with special emphasis on the polarization-momentum correlation methods. Of these methods, only the Mott scattering method has been applied for polarization measurements. Other polarization-momentum correlation methods, single quantum annihilation of positrons, bremsstrahlung, and pair production methods are discussed in some detail. (auth)

**32956** THE INTER-RELATION OF HIGH AND LOW ENERGY NUCLEAR PHYSICS. Burcham, W. E. (Australian National Univ., Canberra). Australian J. Sci., 27: 93-8(Oct. 1964).

Some experiments and models, in what are often regarded as two distinct fields (elementary-particle and nuclear-structure physics), are dealt with to emphasize their interdependence. Properties of the elementary particles which prescribe their classification, and the mutual interactions which dictate their dynamic behavior, have been elucidated by the application of general principles, established as a result of extensive applications in atomic and low energy nuclear physics, within the framework of quantum mechanics. In technique, there is an increasing similarity between the analytical methods of analysis used in high and low energy physics. Phase shift analysis, widely used for determining the parameters of nuclear levels observed in the elastic scattering of protons and $\alpha$ particles, is now being applied in the same way to indicate the spins of nucleon and hyperon isobars. It is suggested that ultimately high energy experiments may reveal the nature of the force between nucleons in sufficient detail for it to be used realistically in calculations of nuclear properties. The role of nuclear structure in high energy physics is also considered, with attempts made to answer the converse problem: to what extent can complex nuclei be used in the study of elementary particles and their interactions? (TCO)

**32957** TARGET TRANSPARENCY AND HIGH-ENERGY COLLISION MECHANISM. Thompson, Charles (Marquardt Corp., Van Nuys, Calif.). Can. J. Phys., 43: 973-9 (June 1965).

Two mechanisms of high-energy inelastic collisions are given, each of which causes an increase in the target radius and its transparency. Thus, the mechanism of shrinkage in the diffraction peak of the elastic event or, in other words, the reason why the target radius can become infinite in the high-energy limit is clarified. (auth)

**32958** ON THE ELECTROPRODUCTION OF STRANGE PARTICLES ON NUCLEONS. Orman, Bryan, A. (Univ. of Alberta, Edmonton). Can. J. Phys., 43: 1115-27(June 1965).

The electroproduction of strange particles on nucleons is discussed, with particular emphasis on the energy region in which the $\pi$-N resonances are dominant. By using the method of Blankenbecler and Gartenhaus, formulas are derived for solving the problems in this region. Differential cross sections of the order of $10^{-39}$ cm$^2$/Mev are obtained. (auth)

**32959** THE CONFORM GROUP AS POSSIBILITY OF UNIFIED SYMMETRY IN PHYSICS OF STRONG INTERACTIONS. Flato, Moshe; Sternheimer, Daniel; Vigier, Jean-Pierre (Institut Henri Poincare, Paris). Compt. Rend., 260: 3869-72(Apr. 5, 1965). (In French)

It is proposed to use the Lie algebra of the restricted conform group as unification of the Lie algebra of Poincare $\mathcal{P}$ and a strong algebra which would be su(2,1). The problem of the representations in finite and infinite dimensions is discussed in relation with the principle of classification of particles and the mass formula. (tr-auth)

**32960** MODIFICATIONS OF REGGE TRAJECTORIES BY A CONTACT POTENTIAL. Jacquemin, Alix (College de France, Paris). Compt. Rent., 260: 4311-14(Apr. 21, 1965). (In French)

The shape of the Regge trajectories relative to a potential containing a contact term were studied. This study which depends on the renormalized scattering amplitude indicates that the Regge trajectories to which the compound particles constructed from this model pertain present some particularities. (tr-auth)

**32961** K MESONS, TIME REVERSAL AND COSMOLOGY. Sciama, D. W. Discovery, 26: No. 5, 9-12 (May 1965).

The present status on the problem of the rare decay of the long-lived $K_2^0$-meson into two mesons is discussed in the framework of CP and T invariance and cosmology. Mach's view on the breakdown of relativity and the gravitational effects of distant galaxies on the earth are considered. The decay phenomena are explained in Lee's theory on the interaction of the K-meson with distant galaxies. The upper limit on the new long range force and experimental tests for its existence are discussed. (L.B.S.)

**32962** SCATTERING OF POLARIZED PARTICLES WITH $^3/_2$ SPIN ON PARTICLES WITH 1 AND 0 SPIN. Gronskii, V. K. (Gor'kii Pedagogical Inst., Minsk). Dokl. Akad. Nauk Belorussk. SSR, 8: 779-83(Dec. 1964). (In Russian)

The method proposed by Bogush for calculating matrix elements of particles possessing 0, 1 and $^1/_2$ spin was applied to the determination of the differential effective scattering cross section of polarized particles with a spin of $^3/_2$. In the case of scattering by particles with a spin of $^1/_2$, the calculation was carried out in the center of inertia system. The operator took into account the anomalous magnetic moment; the effect of this factor on the scattering cross section depends on the initial and final polarization of the particles. If the initial spin values are averaged out, the result obtained for the scattering of nonpolarized particles agrees with the author's previous finding. Scattering by scalar particles which are independent of the anomalous magnetic moment, differs only slightly from the same process by the corresponding Dirac particles. At large energies, divergence of the differential cross section of particles with $^3/_2$ spin follows the square law, thus differing from particles possessing 1 and $^1/_2$ spin. (TTT)

**32963** EMISSION BY ACCELERATED ELECTRONS. Kemeny, Peter. Fiz. Szemle, 15: 16-23(Jan. 1965). (In Hungarian)

The emission of electromagnetic radiation by accelerated electrons is investigated. (D.C.W.)

**32964** UNITARITY AND ON-MASS-SHELL ANALYTICITY AS A BASIS FOR S-MATRIX THEORIES. [PART] I. Gunson, J. (Univ. of Birmingham, Eng.). J. Math. Phys. (N. Y.), 6: 827-44(June 1965).

Many-particle unitarity relations are analyzed and related to maximal analyticity conjectures with particular reference to continuations into unphysical sheets. Poles and cuts associated with unstable particles are treated in detail and generalized unitarity relations are derived. (auth)

**32965** UNITARITY AND ON-MASS-SHELL ANALYTICITY AS A BASIS FOR S-MATRIX THEORIES. [PART] II. Gunson, J. (Univ. of Birmingham, Eng.). J. Math. Phys. (N. Y.), 6: 845-51(June 1965).

Sets of postulates for S-matrix theories are given and used to construct potentially complete dynamical theories for scattering of strongly interacting particles, based essentially on the unitarity relations and on-mass-shell analyticity of scattering amplitudes. In one formulation, the unitarity relations for stable particles are used to derive the corresponding relations for cuts associated with unstable particle states. In a second formulation, an attempt is made to treat stable and unstable particles on a more equal footing. Crossing symmetries and decomposition laws for single-particle poles appear as consequences of the postulates. (auth)

**32966** UNITARITY AND ON-MASS-SHELL ANALYTICITY AS A BASIS FOR S-MATRIX THEORIES. [PART] III. Gunson, J. (Univ. of Birmingham, Eng.). J. Math. Phys. (N. Y.), 6: 852-8(June 1965).

The singularity structure of many-particle scattering amplitudes in momentum transfer variables is investigated in terms of the many-particle unitarity conditions. Cauchy-type kernels for analytic functions defined on complex rotation group in three dimensions are constructed and related to a theory of local representations of the rotation group, corresponding to complex angular momenta. (auth)

**32967** PROJECTED ANGULAR MOMENTUM STATES. Karayianis, N.; Morrison, C. A. (Harry Diamond Labs., Washington, D. C.). J. Math. Phys. (N. Y.), 6: 876-9 (June 1965).

Known results regarding the projection of total spin states from product wavefunctions involving spin-$\frac{1}{2}$ particles are generalized. It is shown that total spin states projected from product wavefunctions involving particles with arbitrary spin, but otherwise restricted to having either maximum or minimum z component of spin, are no more complicated in form than for the spin-$\frac{1}{2}$ case. (auth)

**32968** CONSERVED QUANTITIES ASSOCIATED WITH SYMMETRY TRANSFORMATIONS OF RELATIVISTIC FREE-PARTICLE EQUATIONS OF MOTION. Fradkin, D. M. (Universita, Rome). J. Math. Phys. (N. Y.), 6: 879-90(June 1965).

A general technique is presented for associating conservation laws with the symmetry transformations that leave invariant the relativistic equations of motion for a free particle. These transformations may be either continuous with the identity (such as infinitesimal transformations) or discontinuous (such as reflections). It is found that for each transformation there exists two classes of conservation laws. The number of separate laws within a class depends on the spin of the particles. The particular cases of the Dirac equation and Maxwell's equations are investigated in some detail. For the Dirac equation, conserved quantities involving discontinuous transformations and also matrix elements between particle and antiparticle states are obtained, in addition to the usual conservation laws. Application of the general method to Maxwell's equations yields not only the usual conserved quantities and Lipkin's "zilch," but also twenty new gauge-independent conserved quantities and other additional integrals associated with discontinuous transformations. (auth)

**32969** TRANSFORMATION FROM A LINEAR MOMENTUM TO AN ANGULAR MOMENTUM BASIS FOR PARTICLES OF ZERO MASS AND FINITE SPIN. Moses, H. E. (Massachusetts Inst. of Tech., Lexington). J. Math. Phys. (N. Y.), 6: 928-40(June 1965).

The infinitesimal generators of the inhomogeneous Lorentz group have been given in a basis in which the components of the linear momentum operators are diagonal and in another basis in which the square of the angular momentum is diagonal for all unitary irreducible ray representations of the group. It is shown how the two bases are related for representations corresponding to zero mass and any (finite) spin. It is shown how this relation enables the infinitesimal generators to be integrated in the angular momentum basis and thereby shows how the angular momentum of a particle changes under the inhomogeneous Lorentz group. In particular, the way that the angular momentum of a massless particle of any spin appears in translated and moving frames of reference is studied. (auth)

**32970** CALCULATION OF SOME HOMOLOGY GROUPS RELEVANT TO SIXTH-ORDER FEYNMAN DIAGRAMS. Federbush, Paul (Massachusetts Inst. of Tech., Cambridge). J. Math. Phys. (N. Y.), 6: 941-54(June 1965). (MIT-2098-127).

A homology group that determines an upper bound for the number of linearly independent analytic functions connected with the sixth-order ladder diagram is computed. The formalism is that of Fotiadi, Froissart, Lascoux, and Pham. Calculations use the standard methods of homology theory. (auth)

**32971** SOLUTION OF THE KÄLLÉN-PAULI EQUATION. Pagnamenta, Antonio (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 6: 955-65(June 1965).

The relevant solution is given to the integral equation which Källén and Pauli have derived for elastic V$\theta$-scattering in the Lee model. As an application of this result the exact Tamm-Dancoff solution for the entire V$\theta$-sector is obtained. This includes the amplitudes for V$\theta$- and N2$\theta$ elastic scattering and V$\theta$-N2$\theta$ production, as well as their extensions off the mass shell. (auth)

**32972** MATHEMATICAL STUDY OF THE CUTOFF PROCEDURE FOR DIVERGENT INTEGRALS IN BOUND-STATE PROBLEMS. Mandelbrojt, J. (Faculte des Sciences, Marseilles) and Mandelbrojt, S. J. Math. Phys. (N. Y.), 6: 974-80(June 1965).

The class of conveniently normalized functions having a given rate of decrease at infinity on the real axis is considered. The lower bound of the length of the supports of the Fourier transforms of such a given class functions is evaluated. This could be considered as a refined form of the uncertainty relation. The condition, which is necessary and sufficient for this lower bound to be finite, is indicated. In the physically important case when this lower bound is infinite, a length which is called the natural cutoff of this class of functions is nevertheless defined; it characterizes the interval outside of which the value of the Fourier transform of a function of the given class may be negligible. A construction which gives the cutoff, or the natural cutoff, is given; it is valid for practically any given rate of decrease. The calculation is carried out explicitly in the case of a decrease of the functions characterized by $|F(x)| \leq A\, e^{-\mu|x|}$ (in this case the support of the Fourier transform is necessarily infinite). A canonical function is built such that the abscissa for which it begins to become small should be reasonably considered to be the natural cutoff of the Fourier transform of all the functions satisfying this inequality. The same method can be used for the class of functions satisfying an inequality of the form $|F(x)| \leq A \exp[-C(x)]$, with $\int_1^\infty C(u)u^{-2}\, du < \infty$. (auth)

**32973** ON THE QUANTUM FIELD THEORIES LEADING TO THE CORBEN EQUATIONS. Norton, Richard E. (Space Tech. Labs., Redondo Beach, Calif. and Univ. of California, Los Angeles). J. Math. Phys. (N. Y.), 6: 981-92(June 1965).

Formulations are presented for the second quantized versions of the field theories which lead to Corben's equa-

tions of motion. It is demonstrated that an indefinite metric is required to guarantee positive energies for all the particles, but that otherwise the theories are physically unambiguous. The number and properties of the resulting particles are studied and compared with the conclusions from previous work. Alternative formulations are also discussed. (auth)

**32974** NOTE ON BEG'S APPROACH TO PERATIZATION. Leader, Elliot (Univ. of California, Berkeley). J. Math. Phys. (N. Y.), 6: 996-8(June 1965). (UCRL-11762)

It is shown that Bég's elegant formulation of the peratization result of Feinberg and Pais can be rigorously justified. (auth)

**32975** DISCONNECTED GROUPS AS HIGHER SYMMETRY GROUPS. Klink, W. H. (Johns Hopkins Univ., Baltimore). J. Math. Phys. (N. Y.), 6: 999-1004(June 1965).

Disconnected groups are investigated to see whether they can be used as higher symmetry groups. Some disconnected groups are given which satisfy certain minimal physical conditions. Two disconnected groups are analyzed in detail using little group techniques, and it is shown how a doubling of certain multiplets results, so that particles and their antiparticles are in the same multiplets—rather than being in separate, though equivalent multiplets as in the usual $SU_3$ or $SU_3$ schemes. (auth)

**32976** COMMUTATION RELATIONS OF WEAK CURRENTS IN BROKEN UNITARY SYMMETRY. Fayyazuddin (Atomic Energy Center, Lahore) and Riazuddin. J. Nat. Sci. and Math., 4: 9-16(Oct. 1964).

Equal time commutation relations of weak currents are considered within the framework of broken SU(3) × SU(3). The possibility that the reduced strength of the $\Delta S = 1$ current relative to the $\Delta S = 0$ current may arise due to the breaking of the symmetry is examined. The term which violates the eightfold way is assumed to belong to the representation (1,8) and (8,1) rather than to representation (3,3*) and (3*,3) as previously assumed. (auth)

**32977** EXISTENCE POSSIBILITIES OF $3\pi$ RESONANCE STATE AT 625 AND 1000 Mev AND $4\pi$ RESONANCE STATE AT 1050 Mev. Kao, Ch'ung-sho; Sung, Hang-ch'ang. K'o Hsueh T'ung Pao, No. 11, 1001-3 (1964).

An equation is given for computing the masses of the 3 and $4\pi$ resonance states, whose existence was postulated from experiments conducted by E. Pickup, et al. (Phys. Rev. Letters, 8: 329(1962)) and by W. D. Walker, et al. (Bull. Am. Phys. Soc., 7: 281 (1962)), respectively. It is believed that the $\alpha_1(625)$ and $\beta_1(1000)$ resonances in the $3\pi$ system have the same isotopic spin at T = 1. The two low component wave conditions at $J^P = 0^-$ and $1^+$ are discussed, and the decay characteristics of the particle are tabulated along with other particles in the 8-dimensional state. The peaks previously observed in the $4\pi$ system indicate that the $4\pi$ resonance may have an isotopic spin of 1 and a positive G parity. The computed mass is approximately equal to 1150 Mev, assuming a 8-dimensional state; and it is concluded that the particle is possibly a $K\pi\pi$ resonance at 1175 Mev. (L.B.S.)

**32978** ON THE POSSIBILITY OF DEMONSTRATING THE "SCATTERING OF LIGHT ON LIGHT" WITH AN ACCELERATOR AND A NUCLEAR REACTOR. Bagge, Erich; Wille, Peter (Universitat, Kiel). Naturwissenschaften, 52: 154(1965). (In German)

It is proposed that scattering of light on light could be observed by the permeation of 6-Bev quanta through the strong $\gamma$ field of a nuclear reactor. Numerical calculations indicate that the use of a 5-Mw swimming pool reactor and the DESY accelerator would produce approximately one scattering event per second. Precautions to be observed are indicated. (J.S.R.)

**32979** STRONG INTERACTIONS AND THE DISPERSION THEORY. Kim, Young Duck (Suh-Kang Univ., Korea). New Phys. (Korea), 4: 40-5(1964). (In Korean)

The currently accepted theories on strong interaction are reviewed. The S-matrix theory of scattering is derived from the dispersion theory on the basis of the axiomatic field theory, taking Feynman diagrams into consideration. (TTT)

**32980** A POLYNOMIAL BASE FOR THE REPRESENTATIONS OF $SU_3$. Kleima, D. (Rijksuniversiteit, Groningen, Netherlands). Nucl. Phys., 70: 577-602(1965).

Sets of polynomials in six variables are derived, which transform according to the finite representations of $SU_3$. These polynomials arise as the eigenfunctions of a Casimir operator written as a partial differential operator. (auth)

**32981** SEARCH FOR ($He_4 + n\pi$) AND ($d + d + n\pi$) FINAL STATES IN d–d COLLISIONS AT 3.0 Gev/c. Debaisieux, J.; Grard, F.; Heughebaert, J.; Servranckx, R.; Windmolders, R. (Institut Interuniversitaire des Sciences Nucleaires, Brussels). Nucl. Phys., 70: 603-8(1965).

Interactions between 3 Bev/c incident deuterons and liquid deuterium were analyzed in a bubble chamber experiment. An upper limit of 6.1 $\mu$b (68% confidence level) was set for the cross sections of the reactions $dd \rightarrow He_4\pi^+\pi^-(\pi^0)$ and $dd \rightarrow dd\pi^+\pi^-\pi^0$. For the reaction $dd \rightarrow dd\pi^+\pi^-$, the following result was obtained: $\sigma(dd \rightarrow dd\pi^+\pi^-) = (21.2^{+16}_{-8.5})\mu b$. Cross sections for $He_3$ production in association with pions are also given. (auth)

**32982** THE SCALAR BEHAVIOR OF CHARGED VECTOR MESON THEORY AT HIGH ENERGY. Akyeampong, D. A. (International Centre for Theoretical Physics, Trieste). Nucl. Phys., 70: 630-40(1965).

Applying Salam's gauge approximation technique to the theory of charged vector mesons, it is shown, using two-particle unitarity, that in its high energy aspects, the theory might be analogous to that for scalar mesons only for particular values of the constants of the theory. In particular it is found that Bernstein and Lee's suggestion that an acceptable theory for vector mesons exists only for normal magnetic moment is not substantiated in this approximation. (auth)

**32983** CROSS SECTION AND POLARIZATION IN THE WEAK INELASTIC PROTON-DEUTERON SCATTERING AT 155 Mev. Kuroda, K.; Michalowicz, A.; Poulet, M.; Gomez-Gimeno, F. (Universite de Paris, Orsay, France). Phys. Letters, 16: 133-4(May 15, 1965). (In French)

Cross sections for weakly inelastic scattering of protons by deuterons—in which the incident proton interacts with one of the nucleons of the target, transferring to it just enough energy to disintegrate the deuteron—were measured at eight angles between 5 and 30°. The polarization of the inelastically scattered protons was measured at four of these angles. Differential cross sections were analyzed with an equation developed previously by Cromer, using the impulse approximation. Differences between measurements and predictions are discussed. (M.J.T.)

**32984** THE VECTOR AND AXIAL COUPLINGS OF BROKEN SU(6). Altarelli, G. (Universita, Florence); Buccella, F.; Preparata, G.; Gatto, R. Phys. Letters, 16: 174-6(May 15, 1965).

The weak vector and axial couplings are calculated in broken SU(6) symmetry. The modifications of the predictions of the Gamow-Teller matrix elements for the baryon octet due to symmetry breaking effects are considered, and a definition of the charge conjugation operator in SU(6) is introduced. The known non-renormalization theorem for the vector couplings is found together with the additional result that the axial couplings conserve the same tensor form of their symmetric limit, except that their overall strength is renormalized by an unpredictable amount. The ratio $(-G_A/G_V)$ in neutron beta decay is predicted, in the full symmetric limit, to be 1.67, for the assumption that the vector and axial couplings belong to the same 35 of SU(6). (L.B.S.)

**32985** THE T VIOLATING DECAY OF $\pi^0 \rightarrow 3\gamma$. Berends, F. A. (CERN, Geneva). Phys. Letters, 16: 178-81(May 15, 1965).

The angular distribution for $\pi^0 \rightarrow 3\gamma$ decay is calculated, using a Lorentz gauge invariant, and parity conserving

effective hamiltonian. Remarks are given on the branching ratio of 3γ to 2β decay, and a rough estimate of order $10^{-6}$ is found. (L.B.S.)

**32986** INTRODUCTION OF A PC VIOLATION THROUGH A $SU_3$ TRANSFORMATION. Desplanques, B. (Faculte des Sciences, Orsay, France). Phys. Letters, 16: 181-3(May 15, 1965).

The possibility of obtaining a PC violation in $K^0$ decay by introducing the charge conserving SU(3) transformation, by using the fact that the weak interaction cut off may be large, and by abandoning the usual (current) × (current) hypothesis is shown. (L.B.S.)

**32987** $\bar{U}(12)$ IRREGULAR COUPLING FOR p-$\bar{p}$ ANNIHILATION. Hussain, F.; Rotelli, P. (Imperial Coll. of Science and Tech., London). Phys. Letters, 16: 183-4 (May 15, 1965).

The problem of p-$\bar{p}$ annihilation at rest into two pseudoscalar particles is treated in the $\bar{U}(12)$ symmetry scheme, considering irregular couplings. It is observed that the vector coupling of pseudoscalar particle-antiparticle appears only in the $\underline{143}_D$ amplitude, where $\underline{143}$ is the meson representation in $\bar{U}(12)$. The amplitude consists of two parts, SU(3) and space-time, and it is found that only SU(3) antisymmetric couplings occur in the $143_D$ amplitude. The ratio of annihilation rates was found to be 4:1. Using multiplet masses, the ratio of the $(\pi^+\pi^-)$ decay mode to the K decay modes was found to be 1:4. (L.B.S.)

**32988** RESONANT STATES IN THE $K^+\pi^+\pi^-p$ SYSTEM. Almeida, S. P.; Atherton, H. W.; Byer, T. A.; Dornan, P. J.; Forson, A. G.; Scharenguivel, J. H.; Sendall, D. M.; Westwood, B. A. (Cambridge Univ., Eng.). Phys. Letters, 16: 184-7(May 15, 1965).

A study was made of the $K^+ + p \rightarrow K^+ + \pi^+ + \pi^- + p$ reaction occurring in the hydrogen bubble chamber which was exposed to a separated $K^+$ beam at 5.000 ± 0.005 Bev/c. All four prong events were measured and processed by the Cavendish geometry and fitting program TONY. Invariant mass and Dalitz plots are shown. The dominant resonances produced in the $K^+\pi^+\pi^-p$ final state were found to be K*(890) and N*(1238): about 30% of the events contained both. In addition, a strong peaking in the $I_x = \frac{1}{2}$, $K^+\pi^+\pi^-$ was observed at about 1320 Mev, which appeared to decay predominantly by way of the $K^*(890)\pi^+$ mode. (L.B.S.)

**32989** A SEARCH FOR THE PROCESS $\mu \rightarrow e + \gamma + \gamma$. Bartley, J. H.; Davies, H.; Muirhead, H.; Woodhead, T. (Univ. of Liverpool, Eng.). Phys. Letters, 16: 187(May 15, 1965).

Positive pions were stopped in a plastic scintillator and the process $\mu \rightarrow e + \gamma + \gamma$ was sought during the time interval 100 ns to 5 μs following the arrival of the pion. No events were recorded in the NaI crystals and the scintillation telescope. An upper limit of $2.4 \times 10^{-6}$ was deduced for the branching ratio of $\mu \rightarrow e + \gamma + \gamma$ relative to $\mu \rightarrow e + \nu + \bar{\nu}$. (L.B.S.)

**32990** TIME REVERSAL IN SU(6) AND $\bar{U}(12)$. Elias, D. K.; Papastamatiou, N. J.; Taylor, J. C. (Oxford Univ.). Phys. Letters, 16: 188(May 15, 1965).

The interaction between a quark sextet, a hypothetical quark of opposite parity, and the $\underline{35}$ of pseudoscalar and vector mesons is used to show that time reversal invariance is contradicted in SU(6) but not in $\bar{U}(12)$. (L.B.S.)

**32991** THE REAL PART OF THE SCATTERING AMPLITUDE AT HIGH ENERGIES. Conzett, H. E. (Univ. of California, Berkeley). Phys. Letters, 16: 189-91(May 15, 1965). (UCRL-11967)

It is pointed out that both the necessity for, and the sign of the real part of the nuclear forward scattering amplitude can result from purely absorptive processes. The partial-wave expansion for the scattering amplitude is considered and expressions are obtained for the ratio of the real to the imaginary part, and the amplitude of the outgoing lth partial wave $\eta_l$ in terms of the phase shift $\delta_l$. Spin-independent s-wave scattering is considered, from which negative phase shifts are obtained. (L.B.S.)

**32992** RE-EXAMINATION OF AN $SU_3$ PREDICTION FOR REACTIONS: COMPARISON WITH DIFFERENTIAL CROSS SECTION DATA. Abarbanel, H.; Callan, C. (Princeton Univ., N. J.). Phys. Letters, 16: 191-4(May 15, 1965).

The $SU_3$ predictions for the $\pi^- + p \rightarrow \pi^+ + p$, $K^- + p \rightarrow K^- + p$, and $K^- + p \rightarrow \Sigma^+ + \pi^-$, where unitary symmetry relations have been shown to hold for the total cross sections, are compared with data on differential cross sections. It is shown that although the interactions satisfy the $SU_3$ triangle relation when total cross sections are compared, they do not, when differential cross sections are examined. (L.B.S.)

**32993** ELECTROMAGNETIC DECAYS OF MESONS IN THE QUARK MODEL. Anisovich, V. V.; Anselm, A. A.; Azimov, Ya. I.; Danilov, G. S.; Dyatlov, I. T. Phys. Letters, 16: 194-5(May 15, 1965).

The electromagnetic decays of mesons are considered in the SU(6) symmetry and in the nonrelativistic quark model. The magnetic moments for different transitions of vector mesons into scalar mesons and γ-quantum are given and relations between the transition probabilities are discussed. The quark magnetic moment $\mu_q$ is determined from values of the nucleon magnetic moment, assuming that $\mu_q$ is always equal to the magnetic moment of free quarks. It is concluded from the results that the magnetic moment seems to be nonrenormalizable with the interaction, binding quarks inside the particles. (L.B.S.)

**32994** THE PEIERLS MECHANISM AND THE PROPOSED $D^{+++}$ RESONANCE AT 2520 Mev/$c^2$. Berzi, V. (Universita, Milan); Recami, E.; Ratti, S. Phys. Letters, 16: 196-8(May 15, 1965).

Comments are made on a possible interpretation of the previously reported $pp\pi^+$ peak at 2520 Mev/$c^2$, found in the reaction $p + p \rightarrow p + p + \pi^+ + \pi^-$. Two possibilities are considered for the production mechanism in which the reaction is assumed to proceed in two successive steps: a statistical model and a one pion exchange model. The effective mass distribution $M^*pp\pi^+$ is written in terms of the transition ratio P(W) and f(W) for the process $p + p \rightarrow N_{33}^{++} + p + \pi^-$ and the final state interaction $N_{33}^{++} + p \rightarrow N_{33}^{++} + p$, respectively, and is compared with experimental results. It is concluded that since spin and isospin factor should not modify drastically the shape of f(W), a kinematical effect might contribute to the reaction, but it cannot account for the observed peak in the $pp\pi^+$ effective mass distribution at 2520 Mev/$c^2$. (L.B.S.)

**32995** ON THE FAILURE OF ONE-CHANNEL N/D METHODS WITH INELASTIC UNITARITY. Munczek, H.; Pignotti, A. (Universidad, Buenos Aires). Phys. Letters, 16: 198-200(May 15, 1965).

The results of Squires and Bander et al. are generalized considering Bjorken's matrix representation for the partial wave scattering amplitude and by showing that any one-channel-like method satisfying the usual requirements will necessarily fail in the treatment of scattering processes in which inelastic effects are present, at least in the case in which the first channel is weakly coupled to the others, and there is a bound state in the system of channels 2,..., n when channel one is decoupled. (L.B.S.)

**32996** BARYONIC STATES OF STRANGENESS -2 PRODUCED IN $K^-p$ INTERACTIONS AT 3.0 Gev/c. Badier, J.; Demoulin, M.; Goldberg, J.; et al. (Ecole Polytechnique, Paris). Phys. Letters, 16: 171-4(May 15, 1965).

Results are presented on the production of S = −2 baryonic states using a 3 Bev/c $K^-$ beam with the hydrogen bubble chamber. Dalitz plots and cross sections for the $K^-p \rightarrow \Lambda K\bar{K}$, $K^-p \rightarrow \Xi^-K^+\pi^0$ and $K^-p \rightarrow \Xi^-K^0\pi^+\pi^0$ interactions presented, and the observed resonances $\Xi^*$ (1820), $K^{*+}$ (890), and $\Xi^*$ (1530) are discussed. (L.B.S.)

**32997** ON THE CP VIOLATION IN STRONG INTERACTIONS AND THE ELECTRIC DIPOLE MOMENT OF THE NUCLEON. Jengo, R.; Odorico, R. (Universita, Bologna). Phys. Letters, 16: 168-9(May 15, 1965).

The theoretical implications of a measurement of the static electric dipole moment of the nucleon are reported. The electric dipole moment arising from a T-violation in strong interactions is evaluated, and the experimental limits on I symmetry for T-violation are discussed. The model in which the production of an electric dipole moment requires a perturbation of the vertex by weak interactions yields a value of $\mu e = 0.5 \times e l_{M_N} 10^{-7}$. It is concluded that the failure to detect the E1 moment of the nucleon could be considered as one of the most stringent tests of T conservation in strong non-strange interactions. (L.B.S.)

**32998** NEUTRON-PROTON TOTAL CROSS SECTIONS NEAR 20 Mev, 24 Mev AND 28 Mev. Groce, D. E., Sowerby, B. D.; Morris, J. M. (Australian National Univ., Canberra). Phys. Letters, 17: 40-1(June 15, 1965).

Knowledge of the n-p total cross section contributes to the two-body problem in nuclear physics. This n-p cross section was determined by measuring the transmission through hydrogen of monoenergetic neutrons from the $T(d,n)^4He$ reaction. Using the measured n-p total cross sections and the effective range theory, a semi-empirical formula for the n-p cross section is obtained as a function of neutron energy. (J.F.P.)

**32999** LEPTONIC DECAYS OF $K^0$ MESON AND PC VIOLATION. Aubert, B.; Behr, L.; Canavan, F. L.; Chounet, L. M.; Lowys, J. P.; Mittner, P.; Pascaud, C. (Ecole Polytechnique, Paris and Faculte des Sciences, Orsay, France). Phys. Letters, 17: 59-62(June 15, 1965).

A previous study of the influence of the $\Delta S = \Delta Q$ rule and of PC violation on leptonic decays was used as a basis for reanalyzing previously determined distributions, $N^+(\pi^-e^+\nu)$ and $N^-(\pi^+e^-\nu)$, of leptonic decays of the meson ($K^0$). (J.F.P.)

**33000** COMPARISON OF FORWARD DISPERSION RELATIONS WITH EXPERIMENTS AT 8-, 10-, AND 12 Gev. Lautrup, B.; Olesen, P. (Universitets, Copenhagen). Phys. Letters, 17: 62-5(June 15, 1965).

Using recent experimental data on the real part of the forward $\pi^{\pm}$-p amplitude around 10 Bev, a comparison of forward dispersion relations with experiments in the high energy region is carried out. In this comparison a new method is proposed which tests forward dispersion relations and involves no assumptions whatever about the unknown cross sections above 20 Bev. While no conclusion can be drawn as to the validity of forward dispersion relations, the results indicate that the measurements of the π-N data around 10 Bev should be performed with better accuracy in order to get a definite test of forward dispersion relations. (J.F.P.)

**33001** K-MATRIX TREATMENT OF ABSORPTIVE EFFECTS IN THE PERIPHERAL MODEL. Watson, H. D. D. (Imperial Coll. of Science and Tech., London). Phys. Letters, 17: 72-4(June 15, 1965).

Previous treatments of the effect which the inclusion of absorption on the initial and final states has on the peripheral model gave results which were objected to in practice. An alternative treatment of the effect is given which is free from these defects. Apart from the relativistic validity of the result, its most important feature is the absence of any restriction on the range of the forces. (J.F.P.)

**33002** MESON DECAYS AS POSSIBLE TESTS FOR A STRONG VIOLATION. Fujii, Y.; Marx, G. (Stanford Univ., Calif.). Phys. Letters, 17: 75-7(June 15, 1965).

An attempt is made to investigate transition matrix elements which conserve P, violate C, and either conserve the isospin I or connect the I violation with the emission of real photons and do not contain many particles and high derivatives. The transitions $\rho \to \eta\pi$, $\omega \to \rho\gamma$, and $\varphi \to \rho\gamma$ are considered. (J.F.P.)

**33003** THE DECAY $\varphi \to \pi\pi\gamma$ AS A MEANS FOR DETECTING S WAVE RESONANCES AND C VIOLATION. Prentki, J.; Veltman, M. (CERN, Geneva). Phys. Letters, 17: 77-8(June 15, 1965).

It is pointed out that a careful study of the decay $\varphi \to \pi^+\pi^-\gamma$ can give information on both even spin $\pi\pi$ resonances with isospin 0 and the possible existence of C violating effects in strong interactions. The large $\pi^+\pi^-$ S-wave resonance, called $\epsilon$, for which there was recently some evidence, would show up in the decay studied as a clear bump in the $\pi^+\pi^-$ invariant mass spectrum. The branching ratio of $\varphi \to \pi^+\pi^-\gamma$ should also be quite appreciable, at least 10 to 20%. (J.F.P.)

**33004** CP AND NON-MINIMAL ELECTROMAGNETIC INTERACTIONS. Barshay, S. (Rutgers State Univ., New Brunswick, N. J.). Phys. Letters, 17: 78-80(June 15, 1965).

A possible connection between CP non-invariance and the possible existence of non-minimal electromagnetic interactions is discussed. An experimental test of the notion is emphasized. There seems to be no experimental evidence supporting P separately in strange-particle electromagnetic interactions and C separately in all particle electromagnetic interactions such that an observable non-minimal is excluded. (J.F.P.)

**33005** SCATTERING OF POLARIZED ELECTRONS BY POLARIZED DEUTERONS. Scofield, James H. (Univ. of California, Livermore). Phys. Rev., 139: B47-9(July 12, 1965). (UCRL-12194)

The first-order Born-approximation cross section for the elastic scattering of high-energy electrons by deuterons is given. The dependence on the polarization states of either the initial or final electron and of either the initial or final deuteron is included. The deuteron is treated relativistically as a spin-one particle with charge, magnetic-dipole, and electric-quadrupole interactions. The connection of the current to those in the nonrelativistic, vector-particle, and Kemmer formalisms is given. (auth)

**33006** STATIC STRONG-COUPLING THEORY WITH $\pi$ AND $\eta$ FIELDS. Ramachandran, R. (Univ. of Chicago). Phys. Rev., 139: B110-20(July 12, 1965).

In the framework of the static strong-coupling approximation, a model with a nucleon source and $\pi$ and $\eta$ meson fields is considered. Characteristically different isobar spectra result, depending on whether the ratio of coupling constants of the nucleon to the $\eta$ and $\pi$ mesons is less than or greater than a certain critical value. In the first case the spectrum of excited states is entirely uninfluenced by the $\eta$-meson fields, with the result that the lowest lying excited state is the well-known (3,3) resonance. But if the coupling constants are such that case II is realized, then the isobar spectrum is drastically changed; in particular a $T = \frac{1}{2}$, $J = \frac{3}{2}$ resonance would be expected as the first excited state. The leading term in the strong-coupling approximation of the nuclear force (potential) resulting from the nucleons exchanging $\pi$ and $\eta$ mesons is also derived. (auth)

**33007** BROKEN CHARGE SYMMETRY IN STATIC STRONG COUPLING. Ramachandran, R. (Univ. of Chicago). Phys. Rev., 139: B121-5(July 12, 1965).

Standard perturbation techniques are applied to the study of the energy level splitting in the nucleon isobar states which results from introducing charge-symmetry violation. Whereas the scalar interaction model shows a high sensitivity to the symmetry breaking, the corresponding asymmetries are typically suppressed in the model with pseudoscalar mesons, owing to the interdependence of spin and isospin in the strong-coupling theory. (auth)

**33008** THEORY OF LOW-ENERGY PION-PION SCATTERING. [PART] II. Kang, Kyungsik (Brown Univ., Providence). Phys. Rev., 139: B126-32(July 12, 1965).

Previously published pion-pion calculations were extended by solving numerically the coupled s- and p-wave equations based on a method of the inverse amplitude, to see if the lower partial waves near threshold converge to definite values. Elastic unitarity is still used for the right-hand cut. Numerical calculations show that the s- and p-wave scattering lengths are very much the same as those obtained before by using only the left-hand singularities chosen to have the correct functional forms near the branch

point; however, the position and the width of the p-wave resonance energy are substantially improved. Solutions exhibit results as a function of λ similar to those found previously; a p-wave attraction corresponds to a strong s-wave attraction. Thus it is found that the procedure of constructing the amplitude developed earlier is convincing.. (auth)

**33009** SU(3) SYMMETRY, K → 2π DECAY MODES, AND CP VIOLATION. Biswas, S. N.; Bose, S. K.; Mathur, V. S. (Univ. of Delhi). Phys. Rev., 139: B132-3(July 12, 1965).

A model for the 2π decay modes of the K meson, based on the assumption of the icosuplet transformation property of the weak hamiltonian under $SU_3$, is constructed. The model incorporates CP violation in a natural way. (auth)

**33010** U(3) × U(3) SYMMETRY OF STRONG AND WEAK INTERACTIONS. Hara, Yasuo (Univ.of Chicago). Phys. Rev., 139: B134-6(July 12, 1965).

Many results obtained by the SU(6) symmetry model are shown to be obtained by the U(3) × U(3) symmetry model if we assume that the octet baryon belongs to the (6*,3) and (3,6*) representation along with a yet-to-be-discovered decuplet of spin-$\frac{1}{2}^-$ particles, though one cannot combine particles of different spin in this model. (auth)

**33011** GENERALIZATION OF LEVINSON'S THEOREM TO THREE-BODY SYSTEMS. Wright, Jon Alan (Univ. of California, Berkeley). Phys. Rev., 139: B137-49(July 12, 1965). (UCRL-11896)

Levinson's theorem is generalized to systems of three particles. The usual two-body result relates the number of bound states of given angular momentum to the corresponding eigenphase shifts of the S matrix. Because of disconnected diagrams the three-body S matrix has continuous eigenphase shifts in addition to any discrete ones; however, it is possible to define a unitary connected matrix that has only discrete eigenphase shifts. Levinson's theorem is given in terms of these phase shifts, and it is the same as the usual multichannel result, except that there are an infinite number of eigenphase shifts to be summed over for each value of the total angular momentum. The proof is carried out within the framework of the Faddeev equations by generalizing Jauch's proof for two-body systems. (auth)

**33012** RESTRICTIONS IMPLIED BY LORENTZ AND SPIN INVARIANCE FOR SCATTERING AMPLITUDES. Jordan, Thomas F. (Univ. of Pittsburgh). Phys. Rev., 139: B149-50(July 12, 1965).

A combination of Lorentz invariance and spin independence may restrict scattering amplitudes so severely that no interesting reaction can be described. This is demonstrated for the scattering of two spin-$\frac{1}{2}$ particles with spin independence defined as in a definition of SU(6) for quarks. (auth)

**33013** FIELD-THEORY RESTRICTIONS ON THE UNIFICATION OF SPACE-TIME AND INTERNAL SYMMETRIES. Anderson, James L. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 139: B155-8(July 12, 1965).

The problem of combining the Poincaré group of space-time symmetries and an internal symmetry group S in an over-all group G is considered. It is argued that such an over-all group must have representations that are defined on the space-time manifold. As a consequence it is shown that the over-all symmetry group can at most contain the internal symmetry group as a proper subgroup and that the factor group G/S must be isomorphic to a covering group of P. However, if one also takes account of the fact that the existence of a symmetry group leads to conservation laws, then G must be the direct product of S and a covering group of P. As an additional result we show that the energy-momentum tensor does not contain an internal part, in contrast to the angular-momentum tensor. (auth)

**33014** BALAZS' LOW-ENERGY APPROXIMATION. Golowich, E. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 139: B158-66(July 12, 1965).

Using an approach due originally to Balázs and reformulated to some extent, the problem of simulating short-range forces with a pole approximation in the framework of a partial-wave dispersion relation is studied. The two-particle meson-baryon channels S = −3, T = 0 and S = 0, T = $\frac{1}{2}$ are treated in detail, with particular emphasis placed upon determining the dependence of the solutions upon various parameters occurring in the calculation. Further, a multichannel formulation for the approximation scheme is given. The matching procedure, by which residues of the poles which represent short-range forces are determined, is found to affect the results strongly, whereas the exact location of these poles is relatively unimportant. It is concluded that the method cannot be applied unambiguously, but that inclusion of short-range effects leads to relatively good agreement with experiment in examples treated so far when a technique similar to a cutoff is used. (auth)

**33015** THREE-PARTICLE SCATTERING—A RELATIVISTIC THEORY. Alessandrini, Victor A.; Omnes, Roland L. (Univ. of California, Berkeley). Phys Rev., 139: B167-78(July 12, 1965). (UCRL-11905)

Relativistic extensions of the Faddeev equations for three-particle scattering are given. They are linear integral equations for six amplitudes, one of the particles being off the mass shell. They satisfy exactly three-particle unitarity. These equations are obtained by applying the techniques introduced by Blankenbecler and Sugar of multiladder diagrams. Accordingly, the two-particle scattering amplitudes, which appear in the kernel of the equations, depend on the energy of the third particle. The equations for these amplitudes are studied. If one replaces these two-body amplitudes by phenomenological amplitudes satisfying unitarity, one gets phenomenological relativistic equations for the three-body problem. When the two-body amplitudes are approximated by the contributions of bound states and resonances, the equations can be reduced to a set of integral equations in one variable. As a by-product of this study, the following results were obtained: a new proof of unitarity for the Lippmann-Schwinger and Faddeev equations; a proof of the analytic properties of a resonance form factor in the nonrelativistic theory; a proof of the asymptotic behavior of these form factors, which uses functional-analysis techniques and is a rather general method for investigating the asymptotic behavior of solutions of Fredholm equations. (auth)

**33016** MULTICHANNEL APPROACH TO HIGH-ENERGY PERIPHERAL COLLISIONS. Lichtenberg, D. B.; Williams, P. K. (Indiana Univ., Bloomington). Phys. Rev., 139: B179-83(July 12, 1965).

In the peripheral model for high-energy, two-body inelastic collisions, the Born-approximation amplitudes are modified to take into account absorption effects due to other open channels. This is done to reduce the partial-wave amplitudes, which may otherwise exceed unitarity limits, especially in the lower partial waves. Each off-diagonal element of the S matrix is estimated in terms of the Born amplitude and elastic-scattering parameters, using a formula applied by many authors. Using the fact that the S matrix is unitary a set of equations which relates the diagonal and off-diagonal parts is obtained. Additional assumptions about the phases involved then enable one to determine the elastic-scattering parameters. Thus the angular distributions for elastic scattering as well as the modified inelastic angular distributions are obtained. This procedure differs from that of previous authors who used an experimental elastic differential cross section to obtain the absorption parameters. (auth)

**33017** MOVING BRANCH POINTS IN j PLANE AND REGGE-POLE UNITARITY CONDITIONS. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad); Pomeranchuk, I. Ya.; Ter-Martorosyan, K. A. Phys. Rev., 139: B184-202(July 12, 1965).

Moving branch points in the j plane are investigated on the basis of analysis of multiparticle terms of the unitarity condition in the t channel. A definite assumption about the form of an analytic continuation of these terms into complex j is used. It is shown that in this case in the j plane there arise branch points of the partial amplitude $f_j(t)$ corresponding to the production thresholds of two or more

Regge poles with relative orbital momentum equal to −1. In the case of two zero-spin particles in the intermediate state, the partial wave has a singularity at negative integral values of the orbital momentum. Azimov has found that such singularities shift to the right if the particles in the intermediate state have nonzero spin. The branch points in the j plane result from the extension of this shift throughout the Regge trajectory. This mechanism of emergence of branch points has been indicated by Mandelstam for the case of Feynman diagrams of a certain class. The presence of these branch points at $j = j_n(t)$ where $j_n(t) = n\alpha(t/n^2) - n + 1$ changes essentially the analytic properties of $f_j(t)$ in the t plane, leading to the emergence in the t plane of branch points at $t = t_n(j)$, where $t_n(j)$ is the solution of the equation $j = j_n(t)$. The discontinuity $\delta_t^{(n)} f_j(t)$ of the amplitude $f_j(t)$ on the singularity $t = t_n(j)$ corresponding to the n-Regge-pole production threshold (Regge-pole unitarity conditions) is calculated. It is shown that this discontinuity has a form similar to the conventional unitarity condition. $\delta_t^{(n)} f_j(t) = (1/2i)[f_j(t + i\epsilon) - f_j(t - i\epsilon)]$ being given by the product of the amplitudes $N_{j,n}$ of production of n Regge poles determined above and under a cut made in the t plane from the point $t = t_n(j)$. The discontinuity $\delta_t^{(n)} f_j(t)$ of the amplitude $f_j(t)$ across the cut connected with the branch point $t = t_n(j)$ is calculated at $t \to t_n(j)$. The discontinuity is shown to have the form $\delta_t^{(n)} f_j(t) = \pi B_n [t - t_n(j)]^{n-2}$. This means that the singularity of $f_j(t)$ has a logarithmic character, i.e., near it we have $f_j(t) = A_n + B_n[j - j_n(t)]^{n-2} \ln [j - j_n(t)]$, where $A_n$ and $B_n$ have no singularities at $j = j_n(t)$. The results obtained will be used elsewhere for analysis of the asymptotic behavior of the diffraction scattering amplitude in the region of not-large values of the momentum transfer. (auth)

**33018** STATISTICS OF THE THERMAL RADIATION FIELD. Keller, Evelyn Fox (New York Univ., New York). Phys. Rev., 139: B202-11(July 12, 1965).

The characteristic functional is calculated for a system of bosons obeying linear field equations. The system is assumed to be in equilibrium, and the density matrix is taken to be of the form $\langle\{n\}|\rho|\{m\}\rangle = \Pi_\kappa \delta_{n_\kappa m_\kappa}(1 - z_\kappa) z_\kappa^{n_\kappa}$, where $\kappa$ labels the individual modes. From the characteristic functional, the moments and distribution functions of an arbitrary number of field components are derived. In addition, it is shown how to obtain the density matrix from the characteristic functional, and, for the system in question, the original density matrix is recovered. Explicit calculations are performed for the electromagnetic field in an unbounded domain and in a semi-infinite domain bounded by a perfectly conducting plane. (auth)

**33019** LOWER BOUNDS ON THE INVERSE REACTANCE MATRIX. Hahn, Yukap (New York Univ., New York). Phys. Rev., 139: B212-24(July 12, 1965).

The spectrum of the closed-channel hamiltonian $\mathcal{H}$ in the multichannel scattering problem is bounded from below and by construction is discrete in the energy region below the threshold for new channels. This property has been applied previously to derive a minimum principle which provides an upper bound on the inverse reactance matrix. The discreteness of the spectrum of $\mathcal{H}$ in the region below the threshold for new channels is further exploited here to derive lower bounds. Forms linear as well as quadratic in $\mathcal{H}$ are obtained and their applicability discussed. Extensive use of the Unsöld approximation and the closure properties of the states generated by the various operators is necessary in order to reduce the inequalities to manageable forms. An iterative method to treat the energy shift operator is discussed, and the convergence of the iteration series and its connection to the subtraction terms in the minimum principle are discussed in detail. (auth)

**33020** SPACE AND TIME IN S-MATRIX THEORY. Stapp, Henry P. (Univ. of California, Berkeley). Phys. Rev., 139: B257- (July 12, 1965). (UCRL-11766)

Basic elements of a theory of measurements of space-time correlations are developed within the framework of a strictly mass-shell S-matrix theory. The "$i\epsilon$ rule" for the resolution of pole singularities is derived from a macroscopic mass-shell causality condition. The experimental and theoretical significance of form factors is discussed from the point of view of analytic S-matrix theory. They are defined as constructs of mass-shell functions, and the conditions under which they can be ascribed approximate experimental significance are examined. The possibility that asymptotic field theory is contained within analytic S-matrix theory is briefly discussed. (auth)

**33021** POLARIZATION IN HIGH-ENERGY MESON-BARYON DIFFRACTION SCATTERING. Alexander, G.; Dar, A.; Karshon, U. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Letters, 14: 918-21(May 31, 1965).

The application of the diffraction-scattering model to the polarization behavior in strong-interacting elementary-particle scattering at high energies is discussed. The particular case considered is that of elastic scattering of spin-0 particles by an unpolarized spin-½ particle target. An expression for the polarization is derived. (M.O.W.)

**33022** POSSIBLE DISCREPANCY BETWEEN THE REGGE-POLE HYPOTHESIS AND THE DIFFERENCE OF THE $\pi^+p$ AND $\pi^-p$ DIFFERENTIAL CROSS SECTIONS. Logan, Robert K. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 14: 921-3(May 31, 1965). (MIT-2098-137)

Using the results of a recent study of high-energy $\pi^-p$ charge-exchange data which indicate that the amplitude $A_1$ is dominated by the exchange of a single $\rho$ Regge pole and other experimental information, it is shown that the simple form of $A_0$, using two poles and no spin dependence, is inconsistent with the t dependence of D(t), where D(t) is the difference between the $\pi^+p$ and $\pi^-p$ differential cross sections. (M.O.W.)

**33023** PION-MASS MEASUREMENT BY CRYSTAL DIFFRACTION OF MESONIC X RAYS. Shafer, Robert E.; Crowe, Kenneth M.; Jenkins, David A. (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 923-5(May 31, 1965). (UCRL-16056)

Measurement of the 4F−3D transitions in $\pi$-mesonic calcium and titanium is reported along with the preliminary results of a new determination of the charged pion mass. (M.O.W.)

**33024** MODEL FOR MASS SPLITTINGS OF BARYONS AND MESONS. Duimio, F.; Scotti, A. (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Phys. Rev. Letters, 14: 926-8(May 31, 1965).

Use is made of the hamiltonian previously proposed for the evaluation of the electromagnetic splittings, namely $H_{em} = aQ \cdot Q + b\tilde{M} \cdot \tilde{M}$, where Q and $\tilde{M}$ transform like the charge and magnetic moment, respectively. The discussion concerns the consequences of a model in which medium-strong mass splittings are supposed to be due to the interaction hamiltonian where hypercharge $\gamma$ and "hypermagnetic moment" $M_\gamma$ play the role of Q and M. (M.O.W.)

**33025** "ABNORMAL" QUANTUM NUMBERS AND DECAY CHANNELS: $J^{PG}$ ASSIGNMENT FOR EPSILON; A NORMAL SCALAR OCTET. Loebbaka, David; Pati, Jogesh C. (Univ. of Maryland, College Park). Phys. Rev. Letters, 14: 929-32(May 31, 1965).

The recent indication of an enhancement at about 730 Mev in the recoil spectrum of the proton in $\pi^- + p$ reactions is considered. An investigation is presented assuming that a resonance, such as above, exists which does not decay with appreciable branching ratio to a two- or three-pion system, but shows up in a recoil spectrum, hence is produced with appreciable cross section. Also a study of the possible decay modes of the said resonance for different assignments of its quantum numbers $J^{PG}$, and an estimation of the order of magnitude of the corresponding partial widths, assuming the dominance of low-mass intermediate states, are included. (M.O.W.)

**33026** RESONANCE ANNIHILATION OF POSITRONS IN CHLORINE AND ARGON. Tao, S. J. (Univ. of New South Wales, Australia). Phys. Rev. Letters, 14: 935-6 (June 7, 1965).

The results of a study of lifetime spectra of positrons in

chlorine, $Cl_2-Ar$, and $Cl_2-N_2$ mixtures are presented. The results indicate the existence of resonance annihilation. (M.O.W.)

**33027** C-INVARIANCE VIOLATION IN STRONG AND WEAK INTERACTIONS. Cabibbo, Nicola (Rockefeller Inst., New York). Phys. Rev. Letters, 14: 965-8(June 7, 1965).

The suggestion is made that C invariance need not be at all a basic symmetry of strong interactions. The class of phenomena for which theorems are stated includes the coupling of pseudoscalar particles to spin-$\frac{1}{2}$ baryons, and the coupling of vector mesons to conserved currents of spin-$\frac{1}{2}$ baryons and of spinless mesons. (M.O.W.)

**33028** GENERALIZATIONS OF THE POINCARE GROUP. Budini, P.; Fronsdal, C. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev. Letters, 14: 968-72(June 7, 1965). (IC/65/29)

An investigation of relativistic generalizations of internal symmetry groups is presented. The main conclusion is that an algebra A that includes that of the Poincare group must be a semidirect product with P = A/S. The assumptions under which the result is derived are (1) relativistic covariance and (2) that the mass spectrum is not continuous. Several different choices of S were studied, giving relativistic generalizations of Wigner's supermultiplet theory, as well as Gürsey and Radicati's SU(6) theory. (M.O.W.)

**33029** ANALYSIS FOR THE PRODUCTION OF AN ISOSCALAR S-WAVE DI-PION RESONANCE. Thurnauer, Peter G. (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 14: 985-8(June 14, 1965).

Outlined is a fully relativistic and unitarity-preserving, phenomenological model for the one-pion production reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$. The effects of the (3,3) pion-nucleon resonance on the final two-pion system and the possibility of a di-pion resonance are examined. The tests of the model for a wide range of data serve to ensure its validity and likewise to define its parameters. (M.O.W.)

**33030** EXPERIMENTAL TESTS OF TIME-REVERSAL INVARIANCE IN $K^+_{\mu 3}$ DECAY. Camerini, Ugo (Univ. of Wisconsin, Madison), Hantman, Ronald L.; March, Robert H., et al. Phys. Rev. Letters, 14: 989-91(June 14, 1965).

The invariance of the decay $K^+ \rightarrow \mu^+ + \pi^0 + \nu$ is tested directly by measuring a parameter that vanishes under time reversal, and indirectly by testing whether decay properties are consistent with the requirement that the form factors describing the decay be relatively real. Results are consistent with time-reversal invariance. Data were obtained by stopping $K^+$ mesons in a bubble chamber filled with $C_3F_8$. (M.O.W.)

**33031** PION-PROTON TOTAL CROSS SECTIONS: 400 TO 2000 Mev. Devlin, Thomas J.; Solomon, Julius; Bertsch, George (Princeton Univ. and Princeton-Pennsylvania Accelerator, Princeton, N. J.). Phys. Rev. Letters, 14: 1031-5(June 21, 1965). (PPAD-2137-537)

The total cross section for the scattering of positive and negative pions on protons in the energy range of 400 to 2000 Mev with a statistical uncertainty of about 1% (0.3 to 0.5 mb) is measured. Results are compared with previous data. (M.O.W.)

**33032** PION PRODUCTION BY POLARIZED VIRTUAL PHOTONS. Akerlof, C. W.; Ash, W. W.; Berkelman, K.; Tigner, M. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 14: 1036-9(June 21, 1965).

A new method is proposed for determining the spin and parity and the electromagnetic transformation form factors of nucleon isobars. An experimental test of this technique using the $N^*_{\frac{3}{2}}$ (1238) isobar is presented. (M.O.W.)

**33033** INTERFERENCE BETWEEN THE DECAYS $\rho^0 \rightarrow \pi^+ + \pi^-$ AND $\omega \rightarrow \pi^+ + \pi^-$ IN THE REACTION $\pi + N \rightarrow \pi + \pi + N$. Durand III, Loyal; Chiu, Yuan Tsi (Yale Univ., New Haven.). Phys. Rev. Letters, 14: 1039-43(June 21, 1965).

Reported are calculations which are based on the single-pion-exchange model for $\rho$ production, and the single-$\rho$-meson exchange model for $\omega$ production, with the effects of competition from other inelastic channels included in both cases. Results are compared with those obtained previously. (M.O.W.)

**33034** QUANTUM NUMBER ASSIGNMENTS FOR THE N*(1425) RESONANCE. Adelman, Stuart Lee (Cambridge Univ., Eng.). Phys. Rev. Letters, 14: 1043-6(June 21, 1965).

An analysis of the events in which the N*(1425) resonance seems to occur is presented. Evidence for the assignment of quantum numbers is included. (M.O.W.)

**33035** RENORMALIZATION OF THE WEAK AXIAL-VECTOR COUPLING CONSTANT. Weisberger, William I. (Stanford Univ., Calif.). Phys. Rev. Letters, 14: 1047-51 (June 21, 1965).

As reported previously the integrals of the time component of the vector and axial-vector current octets generate, under equal time commutation, the algebra of $SU(3) \otimes SU(3)$, and these algebraic relations are preserved even though the axial-vector and the strangeness-changing vector currents are not conserved. These nonlinear commutation relations fix the relative scale of the vector and axial-vector matrix elements measured in the weak interactions. These ideas are combined with that of a partially conserved $\Delta Y = 0$ axial-vector current to obtain an expression in terms of $\pi$-proton cross sections for the absolute ratio of renormalized axial-vector and vector coupling constants of ordinary $\beta$ decay. (M.O.W.)

**33036** CALCULATION OF THE AXIAL-VECTOR COUPLING CONSTANT RENORMALIZATION IN BETA DECAY. Adler, Stephen L. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 14: 1051-5(June 21, 1965).

A sum rule is derived expressing the axial-vector coupling-constant renormalization in $\beta$ decay in terms of off-mass-shell pion-proton total cross sections. The derivation and numerical results, which agree to within five percent of experiment, are included. (M.O.W.)

**33037** $K\bar{K}\pi$ RESONANCE AT 1280 Mev. Miller, Donald H.; Chung, Suh Urk; Dahl, Orin I.; Hess, Richard I.; Hardy, Lyndon M.; Kirz, Janos; Koellner, Werner (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 1074-7 (June 28, 1965). (UCRL-16095)

A strong enhancement is reported in the $K\bar{K}\pi$ systems produced in $\pi^-p$ interactions. A peak in the neutral $K\bar{K}\pi$ combinations at M = 1280 ± 10 Mev is reported, and it is interpreted as evidence for a new I = 0 state (D meson). A discussion of possible $I^GJ^P$ assignments is included. A study of resonant states produced in $\pi^-p$ reactions over the momentum interval 1.7 to 4.2 Bev/c is included. (M.O.W.)

**33038** INDICATION OF A $0^+$, T = 0 $2\pi$ RESONANCE AT 720 Mev. Hagopian, V. (Univ. of Pennsylvania, Philadelphia); Selove, W.; Alitti, J.; Baton, J. P.; Neveu-Rene, M.; Gessaroli, R.; Romano, A. Phys. Rev. Letters, 14: 1077-81(June 28, 1965).

The peak recently observed in the neutral meson mass spectrum at about 700 Mev, is now thought to exist in the $2\pi^0$ system. The combined data from previous $\pi^-p$ experiments at 2.75 and 3.0 Bev/c are considered. An indication of a T = 0 s-wave $\pi\pi$ resonance at about 720 Mev with width $\Gamma \sim 50$ Mev is found. The data on which this conclusion is based are reported. (M.O.W.)

**33039** ANTIPROTON-PROTON ANNIHILATION AT REST INTO TWO PSEUDOSCALAR MESONS AND SU(6) SYMMETRY. Konuma, Michiji (Scuola Normale Superiore, Pisa, Italy and Centro Richerche Fisica e Matematica, Pisa, Italy); Remiddi, Ettore. Phys. Rev. Letters, 14: 1082-3(June 28, 1965).

The proton-antiproton annihilation at rest into two pseudoscalar mesons is discussed in the SU(6) symmetry model. This problem including in the final state all the mesons of the 35-plet, was considered previously, but the treatment and results are different. (M.O.W.)

**33040** EQUIVALENCE OF THE CURRENT ALGEBRA AND GROUP-THEORETIC FORMULATIONS IN PARTICLE PHYSICS. Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Phys. Rev. Letters, 14: 1083-5(June 28, 1965).

The formulation involving the space-integrated currents was used previously to rederive several results of the SU(6) and SU(4) theories in a more direct fashion. It is shown that if one uses only the integrated currents, the formulation in terms of the algebra of currents is completely equivalent to a standard formulation of symmetry groups. (M.O.W.)

**33041** SUPERMULTIPLET SCHEMES AND MESON POLE MODELS FOR ELECTROMAGNETIC FORM FACTORS. Freund, Peter G. O.; Oehme, Reinhard (Univ. of Chicago). Phys. Rev. Letters, 14: 1085-7(June 28, 1965).

A special feature of the pole dominance model, which results in the possibility of one alternative set of predictions, is pointed out. Interest is expressed in the electromagnetic vortex for baryons and for SU(3) triplets. The baryon octet is discussed using the spurion scheme of broken M(12) symmetry. (M.O.W.)

**33042** UNIVERSALITY AND M(12) INVARIANCE. Freund, Peter G. O. (Univ. of Chicago). Phys. Rev. Letters, 14: 1088-91(June 28, 1965).

Presented is an M(12) invariant model of electromagnetic and weak form factors of hadrons. A discussion of redundant components of M(12) multiplets is provided with predictions from the model in good agreement with experiment. (M.O.W.)

**33043** BACKWARD PION-NUCLEON SCATTERING AND SPIN DETERMINATION OF PION-NUCLEON RESONANCES. Heinz, Richard M.; Ross, Marc H. (Univ. of Michigan, Ann Arbor). Phys. Rev. Letters, 14: 1091-5 (June 28, 1965).

Previous measurements of the pion-proton total cross section between 2.1 and 5.5 Bev/c have revealed four new resonances, two in each of the isospin states. A method is proposed for determining the spins of the isospin-$\frac{3}{2}$ resonances. This method is based on the assumption that the background amplitude is primarily due to the one-nucleon exchange. (M.O.W.)

**33044** SOME RARE DECAY MODES OF THE $\omega$ MESON AND A SEARCH FOR C-INVARIANCE VIOLATION. Flatte, Stanley M.; Huwe, Darrell O.; Murray, Joseph J.; Button-Shafer, Janice; Solmitz, Frank T.; Stevenson, M. Lynn; Wohl, Charles (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 1095-9(June 28, 1965). (UCRL-16109)

Experimental methods used to measure rare decay modes of the $\omega$ meson are presented. The widths of several decay modes are listed. The $\omega \to \pi^+ + \pi^- + \pi^0$ decay was tested for nonconservation of C and found to be consistent with C conservation. (M.O.W.)

**33045** INTRINSIC SPINS AND THE $\tilde{U}(12)$ THEORY. Harari, H. (Israel Atomic Energy Commission, Yavne). Phys. Rev. Letters, 14: 1100-2(June 28, 1965).

A complete classification of all the possible spin states of a system of any number of quarks and antiquarks in the framework of $\tilde{U}(12)$ is presented. The chain of subgroups $\tilde{U}(4) \supset S\tilde{p}(4) \supset SL(2,c)$ are used, and the spin states are given in terms of the irreducible representations of $S\tilde{p}(4)$. A set of $S\tilde{p}(4)$ selection rules are derived. It is shown that in the limit of strict $\tilde{U}(12)$ symmetry almost all decay modes of the high mesonic and baryonic resonances are forbidden. (M.O.W.)

**33046** EHRENFEST'S THEOREM AND SCATTERING THEORY. Lippmann, B. A. (Defense Research Corp., Santa Barbara, Calif.). Phys. Rev. Letters, 15: 11-14 (July 5, 1965).

The extended Ehrenfest's theorem in a very general form is proven. The theorem is then specialized to apply to momentum transfer, energy transfer, and rotational excitation. (M.O.W.)

**33047** LIE GROUP OF THE STRONG-COUPLING THEORY. Cook, T. (Univ. of Wisconsin, Madison and Argonne National Lab., Ill.); Goebel, C. J.; Sakita, B. Phys. Rev. Letters, 15: 35-8(July 5, 1965).

An attempt is made (1) to show the Lie group of Goebel's theory of strong coupling in static models; from this group the bands of isobar states are obtained as irreducible representations; (2) to give a solution of the problem for two simple cases [symmetric scalar and symmetric pseudoscalar meson theory] by the help of the method of group contraction; and (3) to indicate the possibility of higher symmetries. (M.O.W.)

**33048** NEUTRON-PROTON CHARGE-EXCHANGE SCATTERING IN THE Bev/c REGION. Friedes, J. L.; Palevsky, H.; Stearns, R. L.; Sutter, R. J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 15: 38-41(July 5, 1965). (BNL-9246)

Previous measurements on the n-p elastic charge-exchange cross section at 2.04 and 2.85 Bev are discussed. The results of a continuation of these angular distribution measurements to a laboratory angle of 15° are presented and compared with other independent results. The angular distribution measurements were made at an incident beam momentum of 3 Bev/c. The zero-degree differential cross section was measured at incident momenta of 1.40, 2.35, and 3.55 Bev/c. (M.O.W.)

**33049** SEARCH FOR INTERMEDIATE BOSONS IN HIGH-ENERGY NEUTRINO INTERACTIONS. Burns, R. (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.); Goulianos, K.; Hyman, E.; Lederman, L.; Lee, W.; Mistry, N.; Rettberg, J.; Schwartz, M.; Suderland, J.; Danby, G. Phys. Rev. Letters, 15: 42-5(July 5, 1965).

Continuation of the search for intermediate-boson production via the high energy neutrino reactions $\nu_\mu + Z \to \mu^- + W^+ + Z'$ and $\nu_\mu + Z \to \mu^+ + W^- + Z'$ is reported. No evidence for the existence of W is found, and so results are interpreted in terms of a lower limit on the mass of W, if indeed such a particle were to exist. In order that the limit be reasonably firm, various factors which contribute to the sensitivity are considered. These factors are (1) the expected production cross section as a function of neutrino energy, (2) the neutrino flux, and (3) the efficiency of the detector for the adopted signature. (M.O.W.)

**33050** ELASTIC SCATTERING OF PROTONS, ANTIPROTONS, NEGATIVE PIONS, AND NEGATIVE KAONS AT HIGH ENERGIES. Foley, K. J.; Gilmore, R. S.; Lindebaum, S. J.; Love, W. A.; Ozaki, S.; Willen, E. H.; Yamada, R.; Yuan, L. C. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 15: 45-50(July 5, 1965).

The extension to higher energy of previous measurements of the differential cross section for elastic p-p, $\pi^-$-p, $\bar{p}$-p, and $K^-$-p scattering in the region $|t| = 0.2$ to 1.0 $(Bev/c)^2$, where t is the negative square of the four-momentum transfer, is presented. The region of incident momentum covered was 15 to 26 Bev/c for $\pi^-$-p and p-p and 12 to 16 Bev/c for $K^-$-p and $\bar{p}$-p scattering. The main purpose was to investigate further the energy dependence of the differential cross sections. (M.O.W.)

**33051** PHOTOEMULSION METHOD FOR DETERMINING THE PROPERTIES OF HIGH-ENERGY SECONDARY PARTICLES. Boos, E. G.; Pavlova, N. N.; Takibaev, Zh. S.; Tursunov, R. S. (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Pribory i Tekhn. Eksperim., No. 2, 63-4(Mar.-Apr. 1965). (In Russian)

For the determination of the nature of secondary particles in the high-energy range, the secondary particles from triradial p-n interactions, generating protons with pulses of 19.8 Bev/c, were analyzed. In primary proton tracks, independent confirmation of the accuracy of the method for the identification of the secondary particles was obtained. Relations between the numbers of p-n mesons, $\pi$ mesons, K mesons, and protons were obtained in the different $\rho\beta c$ ranges: $2.5 < \rho\beta c < 5$ Bev – $N_\pi$: $(N_k + N_p) = 90 : 10$; $5$ Bev $< \rho\beta c < 20$ Bev – $N_\pi : N_k : N_p = 47 : 10 : 43$. (tr-auth)

**33052** ON THE PROBLEM OF THE MOTION OF THREE NUCLEONS ALLOWING FOR TENSOR FORCES. Sitenko, A. G.; Kharchenko, V. F. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 10: 469-80(May 1965). (In Ukrainian)

The problem of the motion of three nucleons is considered, the interaction between which is described by Yamaguchi's potential with tensor forces taken into account. The problem of the bound state of the three nucleons and the problem of the scattering of a zero energy neutron by a deuteron are reduced to the solution of systems of one-dimensional integral equations. As a result of the numerical solution of the integral equations it is possible to determine the doublet length of the scattering of a neutron by a deuteron, the binding energy and the wave function of the three nucleons in the bound state. (auth)

**33053** ON THE NUMBER OF DIAGRAMS FOR A TWO-PARTICLE GREEN FUNCTION OF INTERACTING FERMIONS. Akopyan, A. A. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh., 10: 508-11(May 1965). (In Ukrainian)

A previously given method was used to compute the number of topologically nonequivalent linked diagrams for a two-particle Green function for the energetic part proper, as well as the number of compact diagrams. For a two-particle function the computation is performed both in symmetrized and nonsymmetrized technique. The number of compact diagrams as well as of diagrams for the apical part were determined in symmetrized technique only. (auth)

**33054** THE GROUP $B_2$ AND LEPTONIC DECAYS OF STRANGE PARTICLES. Guan, Hong (Peking Univ.). Wu Li Hsueh Pao, 21: 569-76(Mar. 1965). (In Chinese)

Using the hypercharge-change representation, leptonic decays of elementary particles are considered under the symmetry of the group $B_2$. Baryons and mesons are assigned to the 4-dimensional representations of the group $B_2$, then the 10-dimensional regular representation just contains all $|\Delta S| \leq 1$ and $|\Delta Q| \leq 1$ baryonic currents or mesonic currents. Assuming that the weak interaction is mediated by intermediate bosons, and inserting them into the 10-dimensional representation of $B_2$, calculated various leptonic decay rates of strange particles which involve both $\Delta S = +\Delta Q$ and $\Delta S = -\Delta Q$ processes were calculated. The results obtained are not in contradiction with present experimental data. (auth)

**33055** MESON RESONANCE AND THE UNITARY SYMMETRY THEORY. Hsu, Pe-wei (Nankai Univ., China). Wu Li Hsueh Pao, 21: 577-82(Mar. 1965). (In Chinese)

The mass formula which was derived from the theory of unitary symmetry group seems to differ with experiments. This problem is discussed from the point of view of field interaction. The results show that the mixing effects of both T = 0 states one belonging to the one-dimensional representation and the other to the eight-dimensional give a correction to the mass of each of them; and the contradiction between the theory and experiment may be explained. Finally, the K-$\overline{K}$ resonant state is discussed. (auth)

**33056** THE REGGE POLES OF CUT-OFF COULOMB POTENTIAL. Yin, Pong-cheng; Chang, Chun-ting; Zhao, Wan-yun (Futan Univ., Shanghai). Wu Li Hsueh Pao, 21: 583-90(Mar. 1965). (In Chinese)

The analytical properties of the S-matrix of the non-relativistic cut-off Coulomb potential in the complex angular momentum and complex energy planes are discussed. The Regge poles of this S-matrix for four special cases are given, and the first two Regge trajectories are traced by means of numerical calculations. (auth)

**33057** THE GALACTICAL HYPER-CHARGE FIELD AND DECAY OF LONG-LIVED NEUTRAL K-MESONS INTO TWO $\pi$-MESONS. Lyuboshits, V. L.; Okonov, E. O.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 490-6(Mar. 1965). (In Russian)

A general analysis of the properties of classical fields generated by nonconserved charges is performed on the basis of the action-by-contact principle. It is shown that, contrary to a broadly accepted opinion, the introduction of such fields does not imply a breakdown of the conservation of energy. It is also shown, that previous experimental results can not be quantitatively explained by the influence of the discussed fields. (auth)

**33058** VIOLATION OF CP-INVARIANCE AND INTERFERENCE EFFECTS IN THE DECAY OF NEUTRAL K-MESONS INTO TWO $\pi$-MESONS. Lyuboshits, V. L.; Okonov, E. O.; Podgoretskii, M. I.; Tsun-fang, U. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fis., 1: 497-506(Mar. 1965). (In Russian)

Interference effects in $K^0 \to \pi^+\pi^-$ decays are investigated in the case of CP nonconservation. It is shown that these effects have a pronounced character under certain conditions, and that an investigation of them opens a real possibility for the final settling of the question of whether the $K_2^0 \to \pi^+\pi^-$ decay exists. The beats in the $\pi^+\pi^-$ system are considered, both for $K^0$ and $\overline{K}^0$ beams and for the interference of $K_2^0 \to \pi^+\pi^-$ decays with the decay of $K_1^0$ mesons, regenerated in a plate of some matter. It is shown that these effects can be used to measure the mass difference of the $K_1^0$ and $K_2^0$ mesons and to determine the sign of this difference. (auth)

**33059** INFLUENCE OF SPINS ON THE ANNIHILATION AND CREATION OF ELECTRON-POSITRON PAIRS IN WEAK INTERACTIONS. Sokolov, A. A.; Ivanov, Yu. P.; Gal'tsov, D. V. (Moscow State Univ.). Yadern. Fiz., 1: 507-10(Mar. 1965). (In Russian)

The influence of the electron and positron spin direction on their annihilation due to weak interactions is investigated. The results are compared with the corresponding transition due to electromagnetic interactions. The probability of the inverse process is also calculated. (auth)

**33060** ELECTROMAGNETIC HADRON CREATION AND UNITARY SYMMETRY. Rekalo, M. V. Yadern. Fiz., 1: 511-23(Mar. 1965). (In Russian)

From the strong interaction unitary symmetry hypothesis, relations are obtained between the amplitudes of meson-pair photoproduction on baryons, between the creation amplitudes of baryon resonances belonging to the 10-dimensional representation of the $SU_3$ group, and also between the creation amplitudes of hadrons in the annihilation of electron-positron pairs. The interaction violating unitary symmetry but conserving isotopic spin and hypercharge is taken into account in the first approximation of perturbation theory. Relations between the amplitudes of various pole mechanisms of the considered reactions are investigated. These relations are the most convenient for experimental tests. (auth)

**33061** THE $\rho$-MESON MASS-DIFFERENCE. Vasev, V. G.; Pivovarov, V. G. (Inst. of Mathematics and Computer Center, Academy of Sciences, Siberian SSR). Yadern. Fiz., 1: 524-5(Mar. 1965). (In Russian)

A model is suggested to explain the mass difference $\Delta m = m_{\rho^0} - m_{\rho^\pm}$. It is shown that within this model $\Delta m$ depends on the $\pi$-meson electromagnetic form factor. For reasonable values of the form factor, the value $\Delta m$ lies within the experimental accuracies, e.g. for $|F_\pi|_{max} \approx 20$, $\Delta m \approx 6$ Mev is obtained. (auth)

**33062** THE $\pi^- + p \to \pi^+ + \pi^- + n$ REACTION NEAR THE THRESHOLD. I. TOTAL CROSS-SECTIONS AND ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 526-32(Mar. 1965). (In Russian)

Total cross sections for six energy values and angular distributions of secondary particles from the reaction $\pi^- + p \to \pi^+ + \pi^- + n$, in the energy region 200–300 Mev, were measured. (auth)

**33063** ELASTIC pp- AND pd-SMALL ANGLE SCATTERING IN THE ENERGY REGION 2–10 Gev. Kirillova,

L. F.; Nikitin, V. A.; Pantuev, V. S.; et al. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 333-9(Mar. 1965). (In Russian)

Results of differential cross-section measurements for the elastic scattering of protons on protons and deuterons are given for energies, 2, 4, 6, 8, 10 Bev. The investigated region of momentum transfers is $3.10^{-3}$ Bev$^2$/sec$^2$ ≤ |t| ≤ 1.2 Bev$^2$/sec$^2$. Data on the magnitude of the real part of the elastic scattering amplitude are obtained from measurements of the Coulomb and nuclear scattering interference: Re A/Im A = −0.25 ± 0.07 for $E_{kin}$ = 10 Bev and Re A/Im A = −0.17 ± 0.07 for $E_{kin}$ = 2 Bev. The experimental results are compared with predictions from dispersion relations. (auth)

**33064** ON THE FORMATION HYPERONS IN πN AND NN COLLISIONS. Kuchin, I. A.; Usik, P. A. (Inst. of Nuclear Physics, Kazkh SSR). Yadern. Fiz., 1: 547-50 Mar. 1965). (In Russian)

Inelastic scattering of pions and nucleons on nucleons, accompanied by the exchange of one K meson, is studied, using the one-meson approximation with a nucleon form factor. The results of calculations are in reasonable agreement with experimental data on production cross sections and hyperon angular and momentum distributions. The possible role of hyperons in the passage of cosmic rays through the atmosphere is discussed. (auth)

**33065** UNITARY MULTIPLET MIXTURES. Mandel'tzveig, V. B.; Menskii, M. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 1: 551-6 (Mar. 1965). (In Russian)

The possibility is discussed that $\Sigma_{1660}$ and $N_{1510}$ belong to the $\frac{1}{2}^+$ octet, so that an octet−decuplet mixture arises. Mass formulas are obtained for octet−octet, octet−decuplet and decuplet−decuplet mixtures. Relations are obtained between the cross sections of processes of the type meson + proton → baryon resonance + vector meson, under the assumption of two mixing vector meson octets. These relations are in agreement with the existing experimental data. (auth)

**33066** SPECTRA OF THE $K_{e5}$-DECAY. Lyagin, I. V. (Gomil Pedagogical Inst., USSR). Yadern. Fiz., 659-64 (Apr. 1965). (In Russian)

The following correlations in the $K_{e5}$ decay were calculated on the basis of the V−A weak interaction theory: the effective mass spectrum for two and three π-mesons, the electron and π-meson energy spectra and the π-e angular correlation. (auth)

**33067** PRODUCTION OF PSEUDOSCALAR MESONS BY COLLIDING ELECTRON-POSITRON BEAMS. Dzhafarov, I. G. (Moscow State Univ.). Yadern Fiz., 1: 665-7(Apr. 1965). (In Russian)

The creation of pseudoscalar meson pairs in the annihilation of polarized leptons and antileptons is investigated, taking the form factors of all participating particles into account. General formulas are obtained for the differential and total cross-sections; they are analyzed with respect to lepton spin states. Formulas are also given for the inverse process — the lepton annihilation of pseudoscalar mesons. (auth)

**33068** INELASTIC p-p INTERACTIONS WITH LOW MOMENTUM TRANSFER. Bannik, B. P.; Vishki, T.; Seb, To In; Azimov, S. A.; Gulyamov, U. G.; Rakhimbaev, B. G.; Chernova, L. I. (Joint Inst. for Nuclear Research Dubna, USSR). Yadern. Fiz., 1: 676-80(Apr. 1965). (In Russian)

Inelastic pp-interactions for the energies 2.26 and 9 Bev of the initial proton are studied, using the nuclear emulsion method. The energy distributions of slow protons are obtained. When treating the experimental data from the point of view of the isobar model, the relative reaction output with the creation of one or two isobars is estimated qualitatively. (auth)

**33069** ELASTIC SCATTERING OF POSITIVE π-MESONS BY PROTONS AT 3.2-Gev/SEC. Vovenko, A. S.; Grachev, A. G.; Likhachev, M. F.; Matulenko, Yu. A.; Savin, I. S.; Hsu, Yung-chang; Ho, Yuan-fu (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 681-6 (Apr. 1965). (In Russian)

The elastic scattering of positive π-mesons with the momentum 3.20 Bev/c by protons was investigated in the region 0.10 ≤ |t| ≤ 0.53 (Bev)$^2$ of momentum transfers. A scintillation hodoscope consisting of 19 counters was used. (auth)

**33070** THE $\pi^-p \to \pi^+\pi^-n$ REACTION NEAR THE THRESHOLD AND ππ-INTERACTION. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 687-92(Apr. 1965). (In Russian)

The $\pi^+\pi^-$ and $\pi^+n$-systems mass spectra from the reaction $\pi^-p \to \pi^+\pi^-n$ were investigated. The energy and angular distributions of secondary particles were analyzed with accuracy up to linear terms in the relative momenta, and the difference of the lengths $a_0 - a_2$ for ππ-scattering was found to be $+(0.25 \pm 0.05)\hbar/\mu c$. (auth)

**33071** SOME ASPECTS OF THE PHYSICAL APPLICATIONS OF THE UNITARY GROUPS. Komar, A. A.; Manko, V. I.; (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 1: 693-700(Apr. 1965). (In Russian)

The rule concerning the construction of all the weights of an irreducible group representation from the highest weight is substantiated with the help of Young schemes. Formulas for the weight multiplicities are derived for $SU_3$ and $SU_4$. A rule is given for the decomposition of the product of two irreducible representations of the group $SU_n$. (auth)

**33072** A STRONG INTERACTION SYMMETRY MODEL BASED ON THE Sp6 GROUP. Struminskii, B. V. Yadern. Fiz., 1: 701-9(Apr. 1965). (In Russian)

A composite model for the elementary particles is considered in which the 6 fundamental particles form a 6-dimensional representation of the Sp(6) group. Mass formulas are obtained for pseudoscalar and vector mesons. Decays of the φ-meson, some properties of baryon multiplets and selection rules for leptonic strangeness nonconserving decays are considered. (auth)

**33073** ANTIPROTON-PROTON INTERACTION AT NONRELATIVISTIC ENERGIES WITH ACCOUNT OF COULOMB FORCES AND THE NEUTRON-PROTON MASS DIFFERENCE. Strokov, Yu. F. (Inst. of Heat and Mass Exchange, Academy of Sciences, USSR). Yadern. Fiz., 1: 710-14(Apr. 1965). (In Russian)

Antiproton-proton interactions at nonrelativistic energies are treated, taking Coulomb forces and the neutron-proton mass difference into account. The cross sections for elastic scattering, absorption and charge exchange, calculated with the help of the optical model, are compared with experimental results. The account of Coulomb forces and the neutron-proton mass difference improves the agreement between the calculated interaction cross sections and the experimental data. (auth)

**33074** REDUCTION FORMULAS AND REPRESENTATIONS FOR AMPLITUDES OF N-ANGULAR DIAGRAMS. Valuev, B. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 715-20(Apr. 1965). (In Russian)

Formulas are obtained, expressing the amplitude of an arbitrary n-angular diagram (for zero-spin particles) in terms of amplitudes of the order (n − 1) and certain functions of the variables, characterizing the diagram. Using the obtained formulas, the amplitude of any n-angular diagram can be written symmetrically in the form of an integral with respect to a parameter. (auth)

**33075** ELIMINATION OF UNPHYSICAL SINGULARITIES IN THE FEINBERG-PAIS FIELD THEORY OF WEAK INTERACTIONS. Slavnov, A. A.; Shabad, A. E. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 1: 721-8(Apr. 1965). (In Russian)

The scattering amplitude, obtained by Feinberg and Pais by summing the ladder graphs in the unrenormalizable theory of weak interactions, is shown to contain unphysical singularities, both in coordinate and momentum spaces. A method, closely analogous to that of Redmond, is proposed

for eliminating them. The result of Feinberg and Pais does not change in the region of physical importance. (auth)

**33076** ELECTROMAGNETIC MASS DIFFERENCES OF BARYONS AND $SU_6$ SYMMETRY. Dolgov, A. D.; Okun, L. B.; Pomeranchuk, I. Ya.; Solov'ev, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 730-2(Apr. 1965). (In Russian)

Results are presented of calculations of the electromagnetic mass differences of the baryons of the 56-plet. It is found, using the nonrelativistic-quark model, that these baryons are in a state with zero total orbital momentum and that the electromagnetic mass differences are caused by three effects—the difference in electromagnetic mass of the u-quark and the s- and d-quarks, the Coulomb interaction between the quark s, and the interaction between the magnetic moments of the quarks. Quantum numbers involved in the expressions for the values of these interaction effects are derived for the 56-plet baryons using a relation between the charge, spin, and U-spin. The calculated mass differences are presented and compared with results from previous experiments. (M.J.T.)

**33077** REGGE POLES FOR VELOCITY-DEPENDENT POTENTIALS. Seigel, M. (Universitaet, Frankfurt am Main). Z. Physik, 185: 186-98(1965). (In German)

The analytical behavior of the scattering amplitude with respect to energy and angular momentum is considered for a group of soluble velocity-dependent potentials. Generalized Jost functions, as well as trajectories for the poles are given explicitly. In certain cases, the positions of the poles have been determined numerically. (auth)

**33078** COHERENT BREMSSTRAHLUNG OF ELECTRONS. Korobochko, Yu. S.; Kosmach, V. F.; Mineev, V. I. (Leningrad Polytechnic Inst.). Zh. Eksperim. i Teor. Fiz., 48: 1248-56(May 1965). (In Russian)

It was shown experimentally that coherent bremsstrahlung is observable for low-energy (tens of kev) primary electrons. It follows from the kinematics of the process that quasi-monochromatic bremsstrahlung beams can be obtained at primary electron energies of the order of several units or tens of Mev. (auth)

**33079** PARTIAL SCATTERING AMPLITUDES IN THE PRESCRIBED ANGULAR MOMENTA REPRESENTATION. Laperashvili, L. V. (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Eksperim. i Teor. Fiz., 48: 1283-92 (May 1965). (In Russian)

Relativistic partial amplitudes with prescribed angular momenta are considered. Their analytical continuation to the complex momentum plane is carried out. By analyzing the many-particle unitarity condition expressed in terms of these partial amplitudes, it is shown explicitly that negative as well as positive integral values of the angular momentum are involved in formation of the branching points of the scattering amplitude for scalar particles corresponding to the exchange of N Regions. These values, however, satisfy certain inequalities. (auth)

**33080** AN ELECTRON IN A RANDOM FIELD. Andreev, I. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1437-44(May 1965). (In Russian)

An expression is obtained for the averaged Green function of a nonrelativistic electron in a time-independent, statistically homogeneous and isotropic random field. The expression is valid under some very broad assumptions regarding the characteristics of the field. (auth)

**33081** BAROINVARIANCE OF STRONG INTERACTIONS. Shekhter, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 1459-78 (May 1965). (In Russian)

A barospin is introduced, the third component of which is equal to half the baryon charge. It is assumed that strong interactions are approximately invariant with respect to rotation in barospin space—that is, degeneracy with respect to baryon charge occurs. In particular, invariance relative to rotation through 180° about the second axis in barospace leads to conservation of A parity and $\gamma_5$R-invariance of strong interactions. The latter fact permits one to explain the smallness of the neutron electric form factor in the presence of a magnetic form factor of the same order of magnitude as that of the proton. Extension of baroinvariance to weak interactions leads to the result that for lepton decays the vector hadronic current should be a component of the F-octet, whereas the axial current refers to the D-octet. Satisfactory agreement with experiment can also be achieved for hadronic decays. In this case, however, it is necessary to abandon the idea of universality of lepton and nonlepton weak interactions. Baroinvariance leads to the appearance of resonances or even of long-lived hadrons with definite quantum numbers in multi-baryon systems. In particular, a pseudoscalar octet should exist in a two-baryon system. (auth)

**33082** COMBINATIONAL RADIATION FROM A UNIFORMLY MOVING CHARGE. Ryazanov, M. I. (Inst. of Engineering Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1490-8(May 1965). (In Russian)

It is shown that the interaction between the proper field of a uniformly moving charge and excited atoms of matter leads to the appearance of radiation with a frequency which differs from that corresponding to the excitation energy of the atom. The radiation intensity depends on the particle velocity, angle of emission of the quantum, and the excitation energy of the atoms in such a way that in the presence of atoms with a single excited state in matter, the measurement of particle energy on basis of the emission angle of the quantum should be possible. (auth)

**33083** APPLICATION OF LORENTZ' LEMMA TO THE CALCULATION OF THE RADIATION FIELDS OF GIVEN SOURCES IN INFINITE MEDIA. Kondrat'ev, I. G.; Talanov, V. I. (Inst. of Radiophysics Scientific Research, Gorkii, USSR). Zh. Tekhn. Fiz., 35: 571-3(Mar. 1965). (In Russian)

A method is outlined for calculating the radiation field of an arbitrary source distribution in an infinite, linear, homogeneous, but not necessarily isotropic, possibly gyrotropic medium. The method employs the lemma of Lorentz relating the fields and their sources in one medium to those in the transposed medium, described by the transposed dielectric and permeability tensors, and represents a natural generalization to infinite media of the method of Vaynshteyn for treating the excitation of waveguides. The radiation field is expanded in a series of normal plane waves and the expansion coefficients, assumed to be slowly varying functions of position, are obtained with the aid of Lorentz lemma by choosing normal plane waves as the test field in the transposed medium. The method has the advantage over methods based on the usual reciprocity theorem that a knowledge of the fields of elementary sources is not required. The method can also be employed in the case of a nonuniform medium. (ATD)

**33084** REVIEW OF COLLISION THEORY. Wigner, Eugene P. (Princeton Univ., N. J.). p.211-39 of "Energy Transfer in Gases." New York, Interscience Publishers, [1963].

A brief review of collision theory is presented, covering fundamental concepts, R-matrix theory, the Born approximation, the distorted-wave Born approximation, the WKB method, variational principles, and the impulse approximation. (D.C.W.)

## Field Theory and Quantum Mechanics

*Refer also to abstract 32790.*

**33085** (JINR-P-2106) VZAIMODEISTVUYUSHCHEE POLE SO SPINOM 2 I URAVNENIYA EINSHTEINA. (Interacting Field With Spin 2 and Einstein's Equations). Ogievetskii, V. I.; Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 65p. Dep.(mn).

The possible local theories of an interacting symmetric tensor field $h^{\mu\nu}$ are considered in which the equations of motion are compatible with a general Hilbert-Lorentz type linear condition to exclude spin 1. It is shown that for a massless tensor field there exists only one such theory (by assumption of minimal interactions), and its equations of motion coincide exactly with Einstein's equations including all nonlinearities of the latter. That is, the field-theoretical derivation of Einstein's equations are given. In this approach space-time remains flat and nonlinearities intrinsic to Einstein's theory are generated by the requirement for interacting gravitation to have spin 2 without spin 1. For a massless field this requirement is ensured by invariance under gauge transformations which are analogous to the gauge transformations in electrodynamics and are formally equivalent to the general covariant transformations. The generalization of Einstein's equations to the case of a massive tensor field is obtained. Mass terms violate the general covariance and the equivalence principle, but an equality of inertial and gravitational masses remains valid. (auth)

**33086** ENERGY LEVELS IN A YUKAWA POTENTIAL. Rawls, John M.; Schulz, Michael (Michigan State Univ., East Lansing). Am. J. Phys., 33: 444-5(June 1965).

A calculation of selected energy levels in a Yukawa potential utilizing the Bohr theory yields results which are in good agreement with those given by more difficult methods. A new result obtained is an expression for the number of bound states. (auth)

**33087** BRIEF REVIEW OF LORENTZ-COVARIANT SCALAR THEORIES OF GRAVITATION. Harvey, A. L. (Queens Coll., Flushing, N. Y.). Am. J. Phys., 33: 449-60 (June 1965).

An historical review of Lorentz-covariant scalar theories of gravitation is presented. Included are the theory of Poincare, its presentation by Kottler, and its modification by Whitrow and Morduch; the first theory of Nordstroem, its modified form due to Bergmann, the modifications due to Whitrow and Morduch, and the field-theoretic approach of Thirring; the second theory of Nordstroem; and the theory of Kustaanheimo. The extent to which these theories can be said to be in accord with the experimental evidence concerning red shift, advance of the perihelion of Mercury, and deflection of light rays is discussed. It is found that except for red shift, there is, at best, poor agreement and, at worst, disagreement. (auth)

**33088** SEPARABLE NONLOCAL POTENTIALS IN QUANTUM MECHANICS. Nichols, William H. (Univ. of Detroit). Am. J. Phys., 33: 474-80(June 1965).

The chief properties of separable, nonlocal potentials in quantum theory are pointed out and exemplified by solving the Schroedinger equation for the one-dimensional motion of a particle in an attractive separable square well. (auth)

**33089** MINIMUM SIZE OF DENSE SOURCE DISTRIBUTIONS IN GENERAL RELATIVITY. Arnowitt, R. (Northeastern Univ., Boston); Deser, S.; Misner, C. W. Ann. Phys. (N. Y.), 33: 88-107(June 2, 1965).

The properties of very dense sources of the gravitational field are examined. The sources are spherically symmetric initially static distributions of neutral or charged dust, treated as dynamical systems with no phenomenological pressure term. The exterior Schwarzschild solution is analyzed from this point of view as generated by a realistic bare matter stress-tensor with appropriate initial Cauchy data. A coordinate frame is introduced in which the radial coordinate coincides with the invariant distance ($g_{rr} = 1$), and the initial value equations are solved in this frame. The systems considered become, in the limit, models for neutral and charged particles, and so provide solutions for the problems of interaction between point particles and the gravitational field. It is shown that, at the instant of time symmetry, there is a minimum invariant extension for a particle, below which no solution of the field equations exists; this fact emerges especially clearly in the invariant radial frame used here. The clothed (or exterior) mass and invariant properties of the interacting systems as a function of the bare mass, charge, and extension are given. The results are in agreement with those obtained previously in another frame, in terms of whose radial coordinate the particle had vanishing extension in the limit. The significance of the necessary departure of a particle from strictly pointlike structure as a result of its gravitational coupling is discussed. (auth)

**33090** INTEGRO-DIFFERENTIAL EQUATION OF MOVEMENT FOR AN ELECTRON IN INTERACTION WITH THE GRAVIFIC FIELD. Zaganescu, Mircea (Universite, Timisoara, Roumania). Compt. Rend., 260: 3303-5 (Mar. 22, 1965). (In French)

The equation of motion of an electron surrounded by virtual gravitons in the presence of an external gravity field is established. (tr-auth)

**33091** STUDY OF THE JORDAN-THIRY FIELD EQUATIONS IN ADAPTED NATURAL REFERENCE MARK. Dang-Vu-Huyen (Institut Henri Poincare, Paris). Compt. Rend., 260: 4307-10(Apr. 21, 1965). (In French)

The tensor of curvature of the field of the Jordan-Thiry theory has been previously calculated in adapted orthonormal reference mark. It is proposed to calculate them in adapted natural reference mark. The expressions of the tensor of curvature are not the same in the two cases. But it is shown that finally the equations of the field are analogous. It is also shown how to resolve the difficulties of the theory without the need of introducing a pentadimensional index. (tr-auth)

**33092** GENERAL COVARIANCE IN THE THEORY OF THE LORENTZ RELATION. Ivanitskaya, O. S. Dokl. Akad. Nauk Belorussk. SSR, 8: 776-8(Dec. 1964). (In Russian)

The Lorentz covariant theory of elementary particles uses curvilinear coordinates. Generalization of the field theory of elementary particles requires that it should satisfy the principle of general covariance within the framework of the general theory of relativity; this involves transition to noncartesian coordinates. However, such coordinates do not form a linear space and do not follow the basic equation of metrology. It has been proposed to make use of a similar system that does not follow the principle of general covariance and that of the mass-field effect on the space-time geometry. Equations were derived, satisfying the condition that the coefficients of an infinitely small general Lorentz transform be expressed by means of Ricci transform coefficients. (TTT)

**33093** ON THE SELF-ENERGY OF A CHARGED MASS. Scherrer, Willy. Helv. Phys. Acta, 38: 215-26(1965). (In German)

For the self-energy of an uncharged mass the Scherrer linear field theory gave the formula $E = 8\pi\varkappa^{-1}\, a = mc^2$. This formula was expanded to a mass with the charge b with the equation $E = 8\pi\varkappa^{-1}|(a^2 + 1/2\omega\varkappa b^2)^{-\frac{1}{2}}|$. $\omega$ is a real unit about whose sign the available existing premises permit no decision. (tr-auth)

**33094** STRUCTURE OF GRAVITATIONAL SOURCES. Janis, A. I.; Newman, E. T. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 6: 902-14(June 1965).

A definition of multipole structure of gravitational sources is proposed in terms of the characteristic initial data for asymptotic solutions of the field equations. This definition is based upon a detailed study of the corresponding data for the linearized equations and upon the close analogy between the Maxwell and the linearized gravitational fields. (auth)

**33095** NOTE ON THE KERR SPINNING-PARTICLE METRIC. Newman, E. T.; Janis, A. I. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 6: 915-17(June 1965).

It is shown that by means of a complex coordinate transformation performed on the monopole or Schwarzschild metric a new metric (first discovered by Kerr) is obtained. It has been suggested that this metric be interpreted as that arising from a spinning particle. A more complicated in-

terpretation is suggested, namely that the metric has certain characteristics that correspond to a ring of mass that is rotating about its axis of symmetry. The argument for this interpretation comes from three separate phases: the metric appears to have the appropriate multipole structure when analyzed in the manner discussed in the previous paper, in a covariantly defined flat space associated with the metric, the Riemann tensor has a circular singularity, there exists a closely analogous solution of Maxwell's equations that has characteristics of a field due to a rotating ring of charge. (auth)

**33096** METRIC OF A ROTATING, CHARGED MASS. Newman, E. T.; Couch, E.; Chinnapared, K.; Exton, A.; Prakash, A.; Torrence, R. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 6: 918-19(June 1965).

A new solution of the Einstein-Maxwell equations is presented. This solution has certain characteristics that correspond to a rotating ring of mass and charge. (auth)

**33097** UNIFIED DIRAC-VON NEUMANN FORMULATION OF QUANTUM MECHANICS. I. MATHEMATICAL THEORY. Marlow, A. R. (Georgetown Univ., Washington, D. C.). J. Math. Phys. (N. Y.), 6: 919-27(June 1965).

The results of mathematical research which are necessary for a consistent unification of the Dirac and von Neumann formulations of quantum mechanics are collected and presented as a single synthesis. For this purpose, direct integral decompositions of Hilbert space must be introduced into Dirac's formulation of spectral theory and representation theory; true unit vectors in the direct integral decomposition spaces replace unnormalizable vectors of infinite length. It then becomes clear that families of modified Dirac projection operators are simply related to the Radon-Nikodym derivative of von Neumann spectral measures. (auth)

**33098** FRESNEL'S EQUATION OF WAVE NORMALS FOR VACUUM POLARIZATION. APPLICATION TO THE BIREFRINGENCE OF THE VACUUM. Kremer, Hugo F. (Universidade do Parand, Brazil). Phys. Rev., 139: B254-6(July 12, 1965).

Semiclassical methods are used to study vacuum polarization. Using the modified Lagrangian, an equation analogous to Fresnel's equation of wave normals is derived and applied to the study of the birefringence of the vacuum. (auth)

**33099** CYLINDRICAL WAVES IN GENERAL RELATIVITY. Rao, J. Krishna (Gujarat Univ., Ahmedabad, India). Proc. Natl. Inst. Sci. India, Pt. A, 30: 439-44 (July 26, 1964).

Exact wave solutions of the Einstein-Rosen cylindrically symmetric space-time corresponding to the field equations of Lichnerowicz's "total radiation" are derived. Three solutions describing different physical situations are considered. The first solution describes a universe filled with Lichnerowicz's waves. The second and third solutions describe space-times filled with Lichnerowicz's waves going respectively into static empty space-time and Weber-Wheeler's gravitational pulse waves over a sharp boundary. Physically, the solutions are interpreted as representing fluid distributions of photons with null geodesics as world lines of flow. (auth)

**33100** POINT CHARGE RADIATION IN A WAVEGUIDE WITH LAMINATED DIELECTRIC FILLING. Gazazyan, E. D.; Laziev, E. M. Radiotekhn. i Elektron., 10: 676-80 (Apr. 1965). (In Russian)

The problem of charged particles in media with periodically changing dielectric permeability was investigated in the works of Fainberg and Khizhnyak, Ter-Mikaelyan, and others. In the present study, expressions for the intensity and angle of the radiation were obtained using the perturbation theory method. The condition for the formation of the radiation, corresponding to the analogous conditions given by Fainberg and Khizhnyak were also obtained. The results can be used during generation of electromagnetic oscillations. (tr-auth)

**33101** COVARIANT THEORY OF RELATIVISTIC WAVE EQUATIONS FOR ARBITRARY SPIN PARTICLES. Shelepin, L. A. Tr. Fiz. Inst., Akad. Nauk SSSR, 30: 253-321(1964). (In Russian)

The general set properties of relativistically invariant equations—matrix algebra, symmetry properties, calculation methods, and equivalent transformations—are examined, considering primarily the transformation of wave functions into Lorentz groups. The results obtained may be applied to equations with higher derivatives. The set properties of relativistic equations may be investigated by the angular momentum theory or the Racah method, as proposed earlier by the author. A number of correlations were obtained for the transformation matrices, resulting in a great simplification of the Racah method. As a result, the theories of the relativistic equations were clarified from the covariant point of view. Formulas were derived for transformations between the canonic, parametric, tensor and algebraic relativistic equations; and a standard calculation scheme was obtained for all relativistic equations on the basis of Fedorov's studies. In addition, a correlation could be established between the complex spectrum and the relativistic equation theories. This simplification makes it possible to consider symmetry and interaction problems not only when applied to the Dirac equation but to relativistic equations as a whole. (TTT)

**33102** RESONANCE MOTION OF ELECTRONS IN A MAGNETIC FIELD WITH HELICAL SYMMETRY. Marinin, V. G. (Inst. of Physics and Tech., Khar'kov). Ukr. Fiz. Zh., 10: 481-5(May 1965). (In Ukrainian)

It is shown that with a definite ratio between the longitudinal velocity, the cyclotron frequency and the period of the modulating magnetic field with helical symmetry, there occurs a process of energy transmission from the longitudinal to the transverse motion. In a system with a constant step of the modulating magnetic field and a constant cyclotron frequency this process is of a periodic nature, i.e., the transverse energy first increases and attains a maximum value, and then falls to zero. The periodicity depends on the initial energy of the electrons and the magnitude of the modulating magnetic field. A study is also made of the behavior of the particles in a system with a helical modulating magnetic field with variable step, the step of the helical field varying with the change in longitudinal velocity. The quantity of energy redistributed by the electrons, having purely axial motion and various initial longitudinal velocities, is determined. (auth)

**33103** INTERACTION OF ELEMENTARY PARTICLES WITH A GRAVITATIONAL FIELD IN RELATIVITY AND IN THE GENERALIZED LINEAR THEORY OF GRAVITATION. Korkina, M. P. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh., 10: 497-507(May 1965). (In Ukrainian)

Comparisons are made of the interaction between gravitational and electromagnetic fields, the interaction between gravitational and electron—positron fields and self-action of the gravitational field in relativity with the interaction between these fields in the generalized linear theory of gravitation. The generalization of the linear theory of gravitation takes into account the innate nonlinearity of the gravitational field. The interactions considered are identical in both theories up to the second approximation upon the gravitational constant a. This method of considering the interaction with the gravitational field gives considerable simplification in the calculation process and makes it possible to use plane metrics in all approximations of the theory under discussion. (auth)

**33104** CONSTRUCTION OF A NONLINEAR POLARIZATION OPERATOR (CASE OF A LONGITUDINAL FIELD). Piskovoi, V. N.; Tsekvava, B. E. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh., 10: 512-19(May 1965). (In Ukrainian)

The nonlinear polarizability of a system is considered in the case of a longitudinal long-wave external field from the standpoint of polyelectron theory. With the aid of diagram technique for three-temporal Green function a nonlinear polarization operator was constructed, and its dependence on the wave vectors was investigated. The relations established between the polarization operator and the nonlinear

polarizability makes it possible, in principle, to compute the latter by the methods of the quantum field theory. It does not follow directly from Kubo's general formalism for the calculation of kinetic coefficients, where the energy of the interaction of the system with the external field is selected as a perturbation. It is shown that for the calculation of nonlinear polarizability in a good approximation the external field can be replaced by a complete macroscopic field and the screened Coulomb interaction between the electrons may be considered. (auth)

**33105** RELATIVISTIC TWO-DIMENSIONAL MODEL OF A SELF-INTERACTING NON-VANISHING REST MASS FERMION FIELD. Berezin, F. A.; Sushko, V. N. (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 1293-1306(May 1965). (In Russian)

A relativistic two-dimensional (one spatial and one time coordinate) model of a self-interacting fermion field with a nonvanishing rest mass is investigated. The eigenfunctions of the energy operator and scattering operator are found in the nonphysical space of pseudoparticles. The S-matrix for elastic scattering of physical particles is set up by using the improper canonical transformation. (auth)

**33106** SINGULARITY TYPES OF FEYNMAN AMPLITUDES. Asribekov, V. E. (All-Union Inst. of Scientific and Technical Information). Zh. Eksperim. i Teor. Fiz., 48: 1328-40(May 1965). (In Russian)

A consistent analysis of the conditions for the appearance of various types of Feynman diagram singularities such as Landau or non-Landau singularities (or singularities of the second type) is carried out on basis of an algebraic investigation of the extremal equations for the denominator of the corresponding Feynman integral. A complete transition from inner 4-momenta q to loop 4-momenta k and external 4-momenta p is performed in the Landau equation set, and the changes in the structure of the Feynman diagrams in p, k-denotations (as distinct to the structure in q-denotations) are analyzed. A graphic procedure for transforming the Feynman p, k-diagrams is considered which permits one to establish the nature of the diagram reduction responsible for the singularities of the second type. Ordinary diagram reduction is studied by taking into account their effect on the shape of the singularity surface as compared to the corresponding surface of the leading diagram. In conclusion, the general analysis of the types of Feynman diagram singularities is illustrated by considering the case of a 4-tail with a loop. (auth)

**33107** STATE OF AN ELECTROMAGNETIC FIELD WITH A DEFINITE FIELD STRENGTH. Kontorovich, V. M.; Tsukernik, V. M. (Inst of Radiophysics, and Electronics, Academy of Sciences, Ukrainian SSR and Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 48: 1386-92(May 1965). (In Russian)

The states of an electromagnetic field with definite values of the field strength are considered. The wave functions of such states in the occupation number representation are determined. (auth)

**33108** ON AXIOMATIC CONSTRUCTION OF THE SCATTERING MATRIX. 3. THE HEISENBERG AND ASYMPTOTIC REPRESENTATIONS. Medvedev, B. V. (Steklov Inst. of Mathematics, USSR). Zh. Eksperim. i Teor. Fiz., 48: 1479-89(May 1965). (In Russian)

The concept of Heisenberg field operators is introduced, and laws for transition from the asymptotic representation to the Heisenberg representation are established. The relation between the axiomatic theory developed here and the theory as developed by Lehman, Simanzik and Zimmerman and also the usual method for setting up the scattering matrix in terms of the Lagrangian is investigated. (auth)

**33109** THE EQUATIONS OF MOTION OF AN ELECTRON IN THE FIELD OF A TRAVELING ELECTROMAGNETIC WAVE WITH SECOND ORDER NONLINEARITIES INCLUDED. Zhileiko, G. I.; Snedkov, B. A. (Power Engineering Inst., Moscow). Zh. Tekhn. Fiz., 35: 486-8 (Mar. 1965). (In Russian)

The equations of motion of an electron in the field of a traveling wave (in the usual form with the derivatives with respect to distance of the electron energy and phase expressed as functions of the phase and velocity) are transformed by introducing as dependence variables the deviations of the energy and phase from their values on an equilibrium trajectory and expanding in powers of these new dependent variables. The resulting first and second degree equations are discussed, in which terms of higher degree than the first or second in the dependent variables are dropped. These are transformed by introducing the energy on the equilibrium trajectory as the independent variable and are written as second order differential equations for the energy deviation. The equation thus obtained from the second degree equations is solved as a linear differential equation. The third degree equations resulting from the expansion in powers of the energy and phase deviations are also briefly discussed. It is concluded that the proposed method of handling the nonlinearities usually makes it possible to dispense with a numerical integration of the equations of motion in investigations of the dynamics of electrons interacting with the field of a traveling wave. (ATD)

**33110** RELATIVISTIC QUANTUM FIELDS. Bjorken, James D.; Drell, Sidney D. International Series in Pure and Applied Physics. New York, McGraw-Hill Book Company, 1965. 409p. $12.50.

The canonical field theory is developed and closed expressions for propagators and for scattering amplitudes are constructed with the LSZ reduction technique. Feynman graph expansion is dealt with, and the perturbation expansion of the scattering amplitude constructed by canonical field theory is shown to be identical with Feynman rules. With further graph analysis the analyticity properties of Feynman amplitudes are studied to arbitrary orders in the coupling parameter, and dispersion relation methods are illustrated. The finiteness of renormalized quantum electrodynamics to each order of the interaction is proved. (L.B.S.)

**33111** SELECTED PROBLEMS IN QUANTUM MECHANICS. ter Haar, D.; ed. New York, Academic Press, 1964. 406p.

A collection of problems is presented on one-dimensional motion, energy spectrum and wave functions, tunnel effect, commutation relations, Heisenberg relations, spreading of wave packets, operators, de Broglie waves, angular momentum, spin, central field of force, motion of particles in a magnetic field, atoms, molecules, and scattering, in quantum mechanics. The answers and solutions are included. (L.B.S.)

## Geophysics

**33112** (AD-608126) ANTARCTIC RESEARCH AND DATA ANALYSIS. AN ELECTRON BOMBARDMENT THEORY OF HIGH-LATITUDE SPORADIC-E. Scientific Report No. 17. Bennett, S. M.; Noel, T. M. (Avco Corp., Wilmington, Mass. Research and Advanced Development Div.). Sept. 25, 1964. Contract NSF-C255. 48p. (RAD-TR-64-29). $2.00(CFSTI).

On the basis of a power spectrum analysis of the foEs time series at the Antarctic stations Wilkes and Byrd, periodic tendencies of the order of hours were uncovered. The principal (and secondary) periods in hours are Wilkes 1.7 (2.4) Byrd 2.2 (1.1). It is possible to derive a model of quasiperiodic variations which is related to the loss of electrons from the Van Allen radiation belt. Thin-layer sporadic-E results from the magnetospheric time-of-flight spectrometer effect when the source is longitudinally small. The periodicity of the resultant variation in electron density at a point longitudinally removed from the disturbance source (but on the same L-shell) is dependent

upon the particle source spectrum and the Coulomb-scattering loss coefficient, and these factors are, at present, poorly understood. The longitude effect in high-latitude sporadic-E occurrence is ascribed to the longitudinal dependence of the effective loss coefficient for a particle whose mirror point drifts on a surface of constant magnetic field strength. (auth)

**33113** (AD-609404) MEASUREMENT OF THE DENSITY OF FREE ELECTRONS IN THE OUTER IONOSPHERE. Donald J. Farmer and W. A. Robinson (Space Technology Labs., Inc., Los Angeles, Calif.). [1960]. Contracts AF18(600)-1190; AF04(647)-165; and AF04(647)-309. 21p. $1.00(CFSTI).

Three profiles of the density of free electrons in the ionosphere were measured in conjunction with test flights of the Atlas intercontinental ballistic missile. Data extend to an altitude of 815 km for the flight of August 2, 1958, to 960 km for the flight of August 28, 1958, and to 1060 km for that of February 4, 1959. Measurements were made using a modification of Berning's method. Below the level of maximum ionization $h_m$ the agreement with approximate true-height reductions of concurrent terrestrial sounder data is good. Above $h_m$ the results show general agreement with previously known time-averaged distributions derived from satellite observations. The August 2 flight occurred during a period of above normal solar and magnetic activity. The somewhat large value, $4 \times 100000$ per $cm^3$, observed for the electron density at 800 km, compared to $1 \times 1000000$ at 365 km ($h_m$), may be a result of that activity. It is noted that in the exosphere the altitude dependence of the gradient of the electron density is approximately the same for all the three profiles, whereas at a particular altitude the density itself varied by almost an order of magnitude among the profiles. (auth)

**33114** (AD-611437) DIURNAL AND LATITUDE EFFECTS OBSERVED FOR 10-kev ELECTRONS AT LOW SATELLITE ALTITUDES. Fritz, Theodore A.; Gurnett, Donald A. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Feb. 1965. Contract Nonr 1509(06). 60p. $3.00(CFSTI).

Large diurnal and latitude effects were observed for 10-kev electrons, using a low energy electron detector on the low-altitude, high-latitude satellite Injun III. It is found that intense fluxes of low energy electrons, $J(E_e \geq \text{kev}) \geq 2.5 \times 10^7$ electrons ($cm^2$ ster sec)/1, occur only during local night between 1700 and 0700 hours (magnetic local time) and that they occur only between 58 and 76 degrees invariant latitude. These intense fluxes of low energy electrons occur predominantly during periods of high geomagnetic activity. It is also found that a large change in the slope of the electron energy spectrum is associated with the trapping boundary for 40-kev electrons found at high latitudes during local night. This change is from a relatively hard spectrum inside the boundary to a very soft spectrum just outside the boundary. The intense fluxes of very soft electrons found beyond the 40-kev trapping boundary at low altitudes are thought to be related to the intense fluxes of low energy electrons found by Gringauz and by Freeman at great distances on the night side of the earth. (auth)

**33115** (AFCRL-64-892) IONIC REACTIONS IN THE IONOSPHERIC GASES. 1st Annual Summary, January 8, 1963–January 9, 1964. (Birmingham Univ. (England). Dept. of Electron Physics). Sept. 1964. 11p. (AD-608495). $1.00(CFSTI).

A description if given of work concerned with the measurement of the decay constants of the atomic ions $He^+$, $Ne^+$, and $Ar^+$ in their pure parent gases by monitoring the density of these species as a function of time in an afterglow using a time-resolving mass spectrometer and the decay of electron density in these pure gases using a Langmuir probe. (auth)

**33116** (N64-18475) OBSERVATIONS OF SUDDEN IMPULSES IN THE MAGNETOSPHERE OBTAINED FROM EXPLORER XII DATA. [Period Covered]: August 16–December 6, 1961. Nishida, Atsuhiro (Chicago Univ., Ill. Dept. of Geophysical Sciences); Cahill, Laurence J. Jr. (New Hampshire Univ., Durham. Dept. of Physics). Contract NAS-w$^3$-155. 32p. (NASA-CR-53611; UNH-64-2). $3.60(CFSTI).

Explorer XII magnetic records show that a positive sudden impulse on the ground is accompanied by an increase in the field strength within the magnetosphere and, hence, by a compression of the magnetosphere. Similarly, a negative sudden impulse on the ground is associated with a decrease in the field strength and an outward motion of the magnetospheric boundary. The speed of propagation of the field variations through the magnetosphere seems to be close to the hydromagnetic wave speed, although the ray theory is not applicable. (auth)

**33117** (RM-4542(RAND)) SATELLITE-BASED DETECTION OF THE ELECTROMAGNETIC SIGNAL FROM LOW AND INTERMEDIATE ALTITUDE NUCLEAR EXPLOSIONS. Karzas, William J.; Latter, Richard (RAND Corp., Santa Monica, Calif.). June 1965. Contract AF49(657)-9619-SA3. 14p.

A theoretical examination is made of satellite-based detection of electromagnetic signals produced by nuclear explosions at low and intermediate altitudes (a few to 20 or so kms). Since such explosions are particularly difficult to detect, it is suggested that this promising detection technique be included in the Project VELA satellite. (auth)

**33118** (AD-611029) THE SUNRISE EFFECTS IN THE E AND F LAYERS OF THE IONOSPHERE. Dchang, Dchao-shien. Translated by Ng, N. H. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.), from Ti Ch'iu Wu Li Hsueh Pao, 12: No. 1, 12-31(1963). 23p. (TT-65-61680). $2.00(fs), $0.50(mf) CFSTI.

Ionograms from Station Juliusruh/Rugen in East Germany, recorded one minute before and after sunrise during the period November 1958 to October 1959, are analyzed. It is concluded that the E2 layer is a normal layer, controlled purely by solar ultraviolet radiation. The annual variation of the solar height during primary ionization is irregular, whereas the solar height of the F layer has a regular annual variation. A theoretical study of these results shows that there is no screening layer capable of strongly absorbing the relevant solar ultraviolet radiation for both the F and E layers. The maximum electron production rates of the E1 layer for all months and the extraterrestrial intensities of the solar $L_\delta$ radiation related to this layer are calculated. The cause of the E2 layer formation is also examined. (auth)

**33119** (AD-611031) THE ASYMMETRICAL EFFECT OF THE FLARE POSITION ON GEOMAGNETIC ACTIVITY. Zhang, Gong-liang. Translated by Ng, N. H. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.), from Ti Ch'iu Wu Li Hsueh Pao., 12: No. 1, 32-40(1963). 20p. (E-T-Ch-64-10 and TT-65-61682). $1.00(fs), $0.50(mf) CFSTI.

Flares of importance ≥II(+) are grouped according to their heliographic position and magnetic condition of the active regions. The mean daily frequency for $K_p \geq 6$ under different conditions is calculated, using the superposed-epoch method. It is found that for the magnetic group $\beta\gamma + \gamma + \beta_f$, solar flares in the northern hemisphere produce a stronger corpuscular effect than those in the southern, but for the flares in the $\beta_p + \beta$ regions, no such hemispheric asymmetry is found. Also, in the southern hemisphere, western flares have a stronger effect than the central and eastern ones, but in the northern hemisphere, only those in the $\beta_p + \beta$ regions have such an east-west asymmetry. These asymmetric relations appeared in all of the last three sunspot cycles, and were especially conspicuous during the equinoxes. (auth)

**33120** IONIZATION VARIATIONS IN THE $F_2$-LAYER OF THE IONOSPHERE ALONG A DEGREE OF LONGITUDE AS AN EFFECT OF SOLAR PARTICLE RADIATION. Volkmann, Hans-Dieter (Max-Planck-Institut fuer Aeronomie; Institut fuer Ionosphaeren-Physik, Lindau ueber Northeim/Hann, [Ger.]). Arch. Elek. Uebertrag., 18: 14-24(Jan. 1964). (In German)

From the ionospheric observations, which were carried out by a chain of stations along the meridian 15°E during the International Geophysical Year, the mean behavior of the critical frequency of the $F_2$ layer, of the transmission factor, and of the maximum usable frequency are derived as functions of the geomagnetical inclination ("latitude profiles") for days with corpuscular disturbances. For this purpose the mean deviations from the monthly median value on days with disturbances are established for the individual stations ($C_p \geq 1.5$). A systematic geographical distribution of zones with positive and negative deviations is obtained, which also depends on the season. As a rule, positive deviations will prevail near the equator with negative deviations prevailing at higher latitudes. The results can be brought to qualitative agreement with the $F_2$ layer theory devised by Martyn. For a quantitative check, electron profiles would be required which are not yet available today. (auth)

**33121** THE ELECTRIC AND MAGNETIC FIELDS IN A STRATIFIED FLAT CONDUCTOR FOR INCIDENT PLANE WAVES. Dosso, H. W. (Univ. of Victoria, British Columbia). Can. J. Phys., 43: 898-909(May 1965).

The electric and magnetic fields in the upper layer of a stratified flat conductor in the field of plane waves are studied. Expressions for the amplitude and phase of the components of the electric and magnetic fields are obtained and evaluated for various frequencies, angles of incidence, layer thicknesses, depths, and conductivities. The conductivities $\sigma = 10^{-11}$ to $10^{-16}$ emu and the frequencies $f = 10^{-3}$ to $10^{4}$ cycles/second considered are of interest in geophysics. (auth)

**33122** SATELLITE TRANSMISSION MEASUREMENTS OF IONOSPHERIC ELECTRON CONTENT AT A TIME OF LOW SOLAR ACTIVITY. Lyon, G. F. (Univ. of Western Ontario, London). Can. J. Phys., 43: 1059-67(June 1965).

The results of observations of the 54-Mc/s signal from Transit IVA (1961 Omicron 1) during a 12-month period are presented. Total columnar electron content measurements are made by the differential Faraday rotation method. It is shown that the electron content is inversely dependent upon the magnetic-activity index during the summer months, but not during the winter. The presence of horizontal gradients in content is sometimes indicated. It is also found that the variation of electron content with solar zenith angle indicates an ionosphere approximating an ideal Chapman layer. (auth)

**33123** ON AN ELECTRON SOURCE FOR THE OUTER VAN ALLEN RADIATION ZONE. McDiarmid, I. B.; Burrows, J. R. (National Research Council, Ottawa). Can. J. Phys., 43: 1161-4(June 1965). (NRC-8425)

Earlier work suggests that electrons generated in the "tail" of the magnetosphere may form an important source of electrons for the outer radiation zone. The strength of this source is shown to be sufficient to maintain the outer radiation zone because it is strong enough to supply electrons at the rate at which they are lost from the outer zone by precipitation into the atmosphere. (F.S.A.)

**33124** GEOMAGNETIC MICROPULSATIONS IN THE AURORAL ZONES. Wright, C. S.; Lokken, J. E. (Defence Research Board, Victoria, British Columbia). Can. J. Phys., 43: 1373-87(July 1965).

Micropulsation data measured at Fort Churchill and at the near-conjugate stations of Byrd and Great Whale River during the conjugate-point experiment by Stanford University and Pacific Naval Laboratory are reported. All three stations are in the auroral zones; and the data, though discontinuous, cover the period from 1961 to 1963. On the assumption that near-coincidence in time of events should be displayed at two conjugates, attention has been concentrated on the times of occurrence of the relatively numerous polar sudden commencements which often introduce the negative bays. There is a striking and very persistent diurnal variation, with maximum occurrence in the hours 03 to 04 G.M.T., which shows at all three stations, but most clearly at the two conjugates. A small time difference, of about one minute on the average, is apparent between events measured at Byrd and those at Great Whale. There is a tendency for the events to be preceded by a quiet period, and they correspond to sudden changes shown on local magnetograms, and lead to a similar diurnal variation of the magnetic elements H, D, and V. A similar pattern appears in the sudden changes of ionospheric absorption shown on the riometer records from Cape Jones, which is about 180 km from Great Whale River; but adequate data for individual time differences are lacking. The coincidence of nighttime active auroras and micropulsation polar-storm commencements measured at the same station seems to be very close. The quiet daytime auroras often show coincident pulsations of light intensity of the same period as the regular (Pc type) micropulsations. (auth)

**33125** DIURNAL AND LATITUDINAL EFFECTS OBSERVED FOR 10-kev ELECTRONS AT LOW SATELLITE ALTITUDES. Fritz, Theodore A.; Gurnett, Donald A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 70: 2485-2502(June 1, 1965).

Using a low-energy electron detector on the low-altitude, high-latitude satellite Injun 3, large diurnal and latitudinal effects were observed for 10-kev electrons. It was found that intense fluxes of low-energy electrons, $j(E_e \geq 10 \text{ kev}) \geq 2.5 \times 10^{7}$ electrons $(\text{cm}^2 \text{ ster sec})^{-1}$, occur only during local night between 1700 and 0700 hours (magnetic local time) and that they occur only between 58 and 76° invariant latitude. These intense fluxes of low-energy electrons occur predominantly during periods of high geomagnetic activity. It is also found that a large change in the slope of the electron energy spectrum is associated with the trapping boundary for 40-kev electrons found at high latitudes during local night. This change is from a relatively hard spectrum inside the boundary to a very soft spectrum just outside the boundary. The intense fluxes of very soft electrons found beyond the 40-kev trapping boundary at low altitudes are thought to be related to the intense fluxes of low-energy electrons found by Gringauz and by Freeman at great distances on the night side of the earth. (auth)

**33126** EFFECTS OF TIME-DEPENDENT ELECTRIC FIELDS ON GEOMAGNETICALLY TRAPPED RADIATION. Faelthammar, Carl-Gunne (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 70: 2503-16(June 1, 1965).

Large-scale electric potential fields in the magnetosphere are generally invoked in theories of the aurora. It is shown that irregular fluctuations of such fields cause a random radial motion of trapped energetic particles by violating the third adiabatic invariant. When the first and second invariants are conserved, any radial motion of the particles is associated with a corresponding energy change. Some particles move outward and others inward; but, if there is a source in the outer magnetosphere and a sink farther in, there will be a net inward transport and an associated net energy gain. This mechanism supplements that of particle transport by magnetic disturbances, which has already been discussed in the literature. The transport and acceleration of energetic particles by fluctuating electric potential fields have a formal similarity to the so-called stochastic mode of acceleration in synchrocyclotrons. In the magnetosphere, the rate of displacement of trapped particles is found to depend on the spectral power density of the fluctuating electric fields at the azimuthal drift frequency and its harmonics. Which of these frequencies is most important depends on the spatial structure of the fluctuations. The observational data needed for numerical evaluation of the rate of transport are still lacking, but the formulas derived serve the purpose of indicating what properties of the fields are important and ought to be measured experimentally. The effects of magnetic time variations, which have been discussed in the literature under special assumptions, are considered in a more general way. A first-order result is given, which applies not only to initial phases of magnetic storms but also to other types of magnetic time variations. (auth)

**33127** ON THE RELATIONSHIP BETWEEN THE UNIDIRECTIONAL AND OMNIDIRECTIONAL FLUX OF TRAPPED PARTICLES ON A MAGNETIC LINE OF

FORCE. Roberts, Charles S. (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res., 70: 2517-27 (June 1, 1965).

The local magnetic field intensity B is often used as a coordinate for specifying position along a line of force in the earth's magnetic field. An alternate coordinate called x is proposed to specify position along the line when dealing with trapped particles. The value of x at any point is equal to $(1 - B_0/B)^{\frac{1}{2}}$, where $B_0$ is the magnetic field strength at the equator of the line of force. The physical significance of x is that a charged particle will mirror at a value of x equal to the cosine of its pitch angle as it crosses the magnetic equator. It is shown that $j(\mu_0)$, the equatorial particle pitch-angle distribution expressed as a function of pitch angle cosine, and J(x), the omnidirectional particle flux along the line of force expressed as a function of x, are related by integral transformations. The properties of x are such that near the magnetic equator x increases almost linearly with latitude, while B increases from $B_0$ as the latitude squared. Therefore, x is a more sensitive coordinate in the equatorial region than B. A matrix approximation method, usually capable of a few percent accuracy, is developed for transforming between $j(\mu_0)$ and J(x). An example of this matrix transformation scheme is presented, as well as several examples in which $j(\mu_0)$ and J(x) can be expressed in terms of known functions. Various other properties of $j(\mu_0)$, J(x), and the coordinates x and B are discussed. (auth)

**33128** THE EFFECT OF TRANSVERSE ELECTRIC FIELDS ON THE MIRROR POINTS OF CHARGED PARTICLES IN THE MAGNETOSPHERE. Swift, Daniel W. (Univ. of Alaska, College). J. Geophys. Res., 70: 2529-34(June 1, 1965).

The effect of an electrostatic field on the mirror altitudes of charged particles is calculated under the assumption that the magnetic field lines are equipotentials and that the electric field drift velocities are small compared with the particle velocities. It is found that the effect of the electric field on the mirror altitudes of charged particles can be presented as a function of the geocentric distance of the particle in the equatorial plane independent of the explicit form of the electric field. The results of the computation are summarized in two graphs. It is also shown that the presence of a transverse electrostatic field does not affect the longitudinal invariant. (auth)

**33129** ON THE GEOMAGNETIC SOLAR QUIET DAILY VARIATION FIELD DURING THE IGY. Matsushita, S.; Maeda, H. (High Altitude Observatory, Boulder, Colo.). J. Geophys. Res., 70: 2535-58(June 1, 1965).

The geomagnetic solar quiet daily variation field, $S_q$, was studied separately for three longitudinal zones during each of three seasons using IGY data obtained at 69 stations. Equivalent external (overhead) and internal (induced within the earth) electric current systems responsible for $S_q$ variations with respect to dip latitude were estimated by the method of spherical harmonic analysis in each zone for each season. Particularly interesting results are the large current intensity during equinoxes and the asymmetry between the northern and southern hemispheres for equinoctial months and even for the yearly average. (auth)

**33130** ON THE GEOMAGNETIC LUNAR DAILY VARIATION FIELD. Matsushita, S.; Maeda, H. (High Altitude Observatory, Boulder, Colo.). J. Geophys. Res., 70: 2559-78(June 1, 1965).

The geomagnetic lunar daily variation field, L, was studied using all available results of lunar analysis of geomagnetic data from a total of 37 stations. Equivalent external (overhead) and internal (induced within the earth) electric current systems responsible for L variations with respect to dip latitude were estimated by the method of spherical harmonic analysis for each season. The external and internal current systems obtained for a mean lunation during the average solar activity period show more plausible current patterns with reasonable amount of total current intensities than any previously obtained. (auth)

**33131** BALLOON OBSERVATIONS OF AURORAL ZONE X RAYS IN CONJUGATE REGIONS. 1. SLOW TIME VARIATIONS. Brown, R. R. (Univ. of California, Berkeley); Barcus, J. R.; Parsons, N. R. J. Geophys. Res., 70: 2579-98(June 1, 1965).

Conjugate aspects of auroral zone electron precipitation are examined using data from ten simultaneous balloon flights of x-ray detectors from Fairbanks, Alaska, and Macquarie Island, Australia, as well as riometer data from Kotzebue and College, Alaska. These results indicate a close correspondence, in similarity and simultaneity, in regions of near conjugacy over a wide range ($K_p$ = 0+ to $6_0$) of geophysical disturbance. Whereas gross features of activity remain intact, dissimilarities become quite evident at locations well removed from near conjugacy. (auth)

**33132** BALLOON OBSERVATIONS OF AURORAL ZONE X RAYS IN CONJUGATE REGIONS. 2. MICROBURSTS AND PULSATIONS. Brown, R. R. (Univ. of California, Berkeley); Barcus, J. R.; Parsons, N. R. J. Geophys. Res., 70: 2599-2612(June 1, 1965).

Simultaneous balloon observations of x-ray, pulsations in the 5 to 10 second range made from Fairbanks, Alaska, and Macquarie Island, Australia, showed no detailed correlation in time or amplitude. Observations in the northern hemisphere, with two balloon instruments separated by about 150 km in the east-west direction, showed no obvious correlation, but when the separation was reduced to about 100 km in the north-south direction, x-ray pulsations showed in-phase variations. Observations with two balloon instruments separated by 150 km in the east-west direction showed time coincidences for about one-third of the microbursts; the other two-thirds were observed on one balloon or the other. From the small scale size of microburst electron precipitation, it is suggested that magnetospheric plasma instabilities are responsible for the electron bombardment of the auroral zone atmosphere. Similar considerations are suggested for pulsating electron precipitation. (auth)

**33133** AN OBSERVATION OF THE LYMAN-BIRGE-HOPFIELD SYSTEM IN AN AURORA. Isler, R. C.; Fastie, William G. (Johns Hopkins Univ., Baltimore, Md.). J. Geophys. Res., 70: 2613-17(June 1, 1965).

The Lyman-Birge-Hopfield bands of $N_2$ were observed at 2-Å resolution in an aurora. Accurate measurements of intensities were not possible because of rocket malfunctions, but the intensity of any relatively strong band appeared to range from about 0.5 to 5 kR when the 3914-Å band of $N_2^+$ was between 25 and 150 kR. (auth)

**33134** F-LAYER IONIZATION TROUGHS DEDUCED FROM ALOUETTE DATA. Muldrew, D. B. (Defense Research Telecommunications Establishment, Ottawa). J. Geophys. Res., 70: 2635-50(June 1, 1965).

Data obtained on consecutive orbits of the topside sounder Alouette enable contour maps of $f_xF_2$, in which local time is independent of longitude, to be constructed over North America and the North Atlantic Ocean. They (along with data from individual orbits) reveal that at night pronounced minimums of $f_xF_2$ exist which are narrow in latitude and extend in a magnetic east-west direction. On these maps, the minimums of $f_xF_2$ surround some point on the earth's surface in the region of the magnetic pole. The average position of the most southerly minimum in the vicinity of 75°W geographic longitude moves southward from about 62°N geographic latitude at 14 hours local time to a minimum latitude of about 45°N at local midnight and then northward to about 49°N at 07 hours local time. The location of this minimum varies with magnetic activity, and during magnetic disturbances it can occur 10 degrees or more south of its undisturbed location. (auth)

**33135** MEAN IONOSPHERIC SCALE HEIGHTS DEDUCED FROM FARADAY ROTATION MEASUREMENTS. Potts, Byron C. (Ohio State Univ., Columbus). J. Geophys. Res., 70: 2651-63(June 1, 1965).

The polarization fading rate of the 54-Mc/s radio transmissions from the Transit 4A satellite is used to obtain a "best fit" Chapman distribution for the ionospheric electron density. The results lead not only to the total electron content, but also to mean values of the ionospheric scale

height. These scale heights are shown to vary with the time of day and solar activity. (auth)

**33136** ELECTRON AND MOLECULAR NITROGEN TEMPERATURE AND DENSITY IN THE THERMOSPHERE. Spencer, N. W. (Goddard Space Flight Center, Greenbelt, Md.); Brace, L. H.; Carignan, G. R.; Taeusch, D. R.; Niemann, H. J. Geophys. Res., 70: 2665-98(June 1, 1965).

Four rocket-borne ejectable instruments, called thermosphere probes, launched into the thermosphere above Wallops Island, Virginia, measured the concentration and temperature of molecular nitrogen and electrons under various atmospheric conditions during the period approaching solar minimum. A fixed-tuned omegatron mass spectrometer mounted within an orificed chamber was used for the $N_2$ concentration measurements. The gas temperature was derived from the $N_2$ scale height, and in some cases was measured directly by a velocity-scan technique. Cylindrical and hemispherical Langmuir probes were used for the electron temperature and density measurements. The four launchings were carried out in the afternoon, at sunset, at night, and during the July 20, 1963, solar eclipse. Calculations of energy deposition confirm earlier experimental and theoretical results which show that solar extreme ultraviolet is the major source of electron heating in the daytime F-region. This is also clear from the factor of 2 reduction of F-region electron temperature during the eclipse. The heating observed in the E-region can be explained only in part by solar x rays and appears to require an additional source such as an electric field. The gas temperatures agree well with theoretical model temperatures, but the model values of $N_2$ concentration appear to be high by about a factor of 2. The flights reveal a temporal variation in $N_2$ concentration in the lower thermosphere which may be either diurnal or seasonal. These variations suggest either large temperature variations below the diffusion level or mass motion phenomena such as winds or tides. Comparison of electron temperature and density data with simultaneous data from Explorer 17 obtained during a flight launched over the satellite shows the measurements to agree among themselves and to be consistent with ionosonde electron density results. (auth)

**33137** GEOMAGNETIC AND SOLAR DATA. Lincoln, J. Virginia, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 2709-11(June 1, 1965).

Data on geomagnetic activity in 1963, the first two months of 1964, and January, 1965 are tabulated, together with provisional sunspot numbers for January 1965. Final sunspot numbers for the whole disk of the sun are included for 1964. (D.C.W.)

**33138** HYDROMAGNETIC EMISSIONS (Pc 1) OBSERVED SIMULTANEOUSLY IN THE AURORAL ZONE AND AT LOW LATITUDES. Tepley, Lee (Lockheed Missiles and Space Co., Palo Alto, Calif.); Heacock, R. R.; Fraser, B. J. J. Geophys. Res., 70: 2720-5(June 1, 1965).

The frequency-time characteristics of hydromagnetic emissions were recorded simultaneously in the auroral zone and at low latitudes. On some occasions the emissions exhibit almost identical characteristics over a great geographic range. (D.C.W.)

**33139** MIDLATITUDE IONOSPHERIC TEMPERATURES ON MAGNETICALLY QUIET AND DISTURBED DAYS. Evans, J. V. (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res., 70: 2726-32(June 1, 1965).

The average variations of the electron and ion temperatures with height in the ionosphere were obtained for geomagnetically disturbed and quiet days by observations with a vertically directed radar beam. The average variation of the heat flux to the electron gas was determined, together with fractional increases in temperature at different heights. Additional evidence of increased electron and ion temperatures at F-region heights under magnetically disturbed conditions was obtained. (D.C.W.)

**33140** RADIATION FROM ELECTRONS IN MAGNETOPLASMA. Liemohn, Harold B. (Southwest Center for Advanced Studies, Dallas). J. Res. Natl. Bur. Std., 69D: 741-66(May 1965).

The radiation from an electron in a homogeneous magnetoplasma has some unusual properties as a consequence of the dispersive anisotropic nature of the medium. Attention is confined to emission in the ordinary (whistler) mode frequency band below the cyclotron resonance and the extraordinary mode frequency band around the plasma frequency where the indices of refraction are appreciably greater than one and vary significantly. Due to the large indices, electrons can emit Cherenkov radiation over a limited band of nonrelativistic energies. The cyclotron radiation which is generated by the gyrations of electrons is complicated also by this property of the medium which permits both normal emission due to slower-than-light motion and anomalous emission due to faster-than-light motion. In the ordinary mode, for example, the anomalous cyclotron radiation is emitted into the forward hemisphere with respect to the guiding center motion of the electron whereas the normal radiation is emitted into the backward hemisphere. The frequency spectra and angular patterns of the average radiated power are calculated by the hamiltonian method which avoids a direct calculation of the complicated electromagnetic field vectors. The theory of emission in dispersive anisotropic media with a hermitian dielectric tensor by Kolomenskii and Eidman is thoroughly reviewed and extended to include relativistic energies; the complicated analytic formulas for the power are evaluated for several special cases; and the results are applied to recent interpretations of very low-frequency (VLF) and low-frequency (LF) emissions from electrons in the magnetosphere. The main conclusions of the work are as follows: In the ordinary (whistler) mode most of the energy is radiated along wave normals at large angles to the magnetic field at frequencies other than the rectilinearly Doppler-shifted fundamental cyclotron harmonic which is contrary to assumptions of certain VLF emission theories. The resonance singularities in the indices for a cold, collisionless plasma must be eliminated to achieve finite power levels, but unfortunately the dielectric tensor for thermal motion is extremely complex and for collisions is non-hermitian; consequently, an arbitrary upper limit is imposed on the indices in order to make a quantitative estimate of the power. Based on this approximation the total power in the ordinary mode is a slowly varying function of frequency and electron energy with an average level of $10^{-30}$ w/(c/s) per electron. This level is inadequate to explain observed VLF signals on the basis of incoherent emission, but coherent emission from bunches of electrons can give the observed power level of $10^{-14}$ w/cm$^2$(c/s) above the ionosphere; hence, the onus of explaining the complex dispersion patterns of VLF emissions is left to the coherence mechanism. The radiation in the extraordinary mode varies considerably with frequency and energy but an average power level is on the order of $10^{-25}$ w/(c/s) per electron which still requires some coherence to generate the observed level above the ionosphere; however, this energy cannot penetrate the ionosphere to account for the dispersion observed by ground-based receivers. (auth)

**33141** PHASE VELOCITIES AND ATTENUATION DISTANCES IN THE IONOSPHERE. Croley, D. R., Jr. (McDonnell Aircraft Corp., St. Louis); Tanenbaum, B. S. J. Res. Natl. Bur. Std., 69D: 819-25(June 1965).

Plane-wave phase velocities and attenuation distances in an infinite, homogeneous, partly ionized gas composed of an interacting mixture of neutral molecules, ions, and electrons in the presence of a uniform magnetic field are determined for three sets of plasma conditions corresponding to the 80, 100, and 300 km levels of the ionosphere. Propagation in the parallel direction and the perpendicular direction relative to the magnetic field in the frequency range from approximately $10^{-5}$ Hz to $10^9$ Hz is considered. (auth)

**33142** IONOSPHERIC EFFECTS OF ELECTROSTATIC FIELDS GENERATED IN THE OUTER MAGNETOSPHERE. Reid, George C. (National Bureau of Standards, Boulder, Colo.). J. Res. Natl. Bur. Std., 69D: 827-37(June 1965).

The conduction of electrostatic fields from the outer magnetosphere to the ionosphere via the geomagnetic field lines is studied in a quantitative fashion. It is assumed

that any arbitrary pattern of turbulent fields in the magnetosphere can be analyzed into Fourier components, and the transfer of components whose wavelength lies between 0.1 km and 1000 km (as measured in the ionosphere) is examined. It is concluded that components of wavelength less than about 1 km will be severely attenuated before reaching the F region, whereas components with wavelength greater than about 10 km will be only slightly attenuated. The application of these results to the theory of the origin of ionospheric irregularities is discussed. The transfer of these electrostatic fields must necessarily be accompanied by the appearance of weak electrostatic fields along the direction of the magnetic field. The size of these fields is estimated, and their possible effect on the acceleration of electrons is discussed. (auth)

**33143** CONCERNING THE MECHANISM OF REFLECTION OF ELECTROMAGNETIC WAVES FROM AN INHOMOGENEOUS LOSSY PLASMA. Wait, James R. (National Bureau of Standards, Boulder, Colo.). J. Res. Natl. Bur. Std., 69D: 865-9(June 1965).

The reflection of electromagnetic waves from a stratified lossy inhomogeneous plasma is investigated. The profile for the conductivity is idealized as an exponential curve with a superimposed Gaussian-shaped perturbation. By examining the change in the calculated reflection coefficient for various locations of the perturbation, some insight into the reflection process is gained. In particular, it is shown that reflection does not take place at a single level but, instead, a wide range of levels is important. The parameters of the problem are chosen to be representative of the D layer of the ionosphere and the wavelengths cover the range 10 km to 30 km. (auth)

**33144** OBSERVATION OF NEARLY MONOENERGETIC HIGH-ENERGY ELECTRONS IN THE INNER RADIATION BELT. Imhof, W. L.; Smith, R. V. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev. Letters, 14: 885-7(May 31, 1965).

Sharply peaked electron spectra observed in the inner belt are discussed. The measurements were performed from an earth-oriented satellite in polar orbit with 355-km apogee and 288-km perigee. Diagrams illustrating the energy and systematic decrease in peak intensity of the electrons are given. (M.O.W.)

**33145** RADIAL DEPENDENCE OF ENERGETIC ELECTRON FLUXES IN THE TAIL OF THE EARTH'S MAGNETIC FIELD. Anderson, Kinsey A. (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 888-90(May 31, 1965).

Electron fluxes out to a geocentric distance of 31.5 earth radii were investigated with the aid of thin-window Geiger-Mueller tubes arranged to discriminate against proton and bremsstrahlung counts. The result is that electron fluxes observed at the satellite show two characteristic time constants, one on the order of one minute and the other many minutes to a few hours. (M.O.W.)

**33146** DIAMAGNETIC RING CURRENT THEORY OF THE NEUTRAL SHEET AND ITS EFFECTS ON THE TOPOLOGY OF THE ANTISOLAR MAGNETOSPHERE. Wentworth, R. C. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev. Letters, 14: 1008-10(June 21, 1965).

The existence of special orbits in the tail of the magnetosphere which will carry solar plasma from the dawn to the dusk side is reported. As this plasma drifts westward through the tail it constitutes a westward-flowing diamagnetic ring current which weakens the field in the equatorial plane. It is suggested that this mechanism is responsible for the formation of the neutral sheet previously observed. (M.O.W.)

**33147** THE MAGNETOSPHERE AND ITS ENVIRONS. Piddington, J. H. (Commonwealth Scientific and Industrial Research Organization, Sydney). Planetary Space Sci., 13: 363-76(May 1965).

Recent observations of the distant geomagnetic field and plasma and of electrons being precipitated provide confirmatory evidence of a geomagnetic tail, proposed some years ago. This and other indirect evidence is used to construct a scale model, sketched from three directions. The tail extends far beyond the Earth's orbit, also covering most of the rear of the magnetosphere proper (MP). The tail surface and the surface of MP meet in a neutral line where there is an abrupt change in field direction and where the whole magnetosphere is likely to be vulnerable to external plasma. The MP may have one or two "wings" stretching out near the dawn and dusk meridians; from the dawn wing field lines and plasma are driven continually into the tail. This motion causes a flow of lines to the interior of the tail where they join at a second neutral line and then contract as a hydromagnetic wave back into MP along the night auroral zone. The flow continues around the auroral zone to the noon meridian and then out to the surface of the MP. Outside the magnetosphere an intermittent shock wave occurs; the plasma is heated and >40 kev electrons also appear in this hemisphere only. Some other models of the magnetosphere are discussed and it is concluded that the usual determination of the invariant latitude of the neutral points is in error because of neglect of Earth currents. It is also concluded that twisting of the tail sections by the rotating Earth is negligible because the field lines are not frozen into the polar ionosphere. (auth)

**33148** ON THE AMPLIFICATION OF ELF EMISSIONS BY CHARGED PARTICLES IN THE EXOSPHERE, WITH SPECIAL REFERENCE TO THE FREQUENCY BAND AROUND THE PROTON CYCLOTRON FREQUENCY. Hultqvist, Bengt (Kiruna Geophysical Observatory, Sweden). Planetary Space Sci., 13: 391-401(May 1965).

Using a collisionless warm-plasma model having different temperatures along and perpendicular to the geomagnetic field and a macroscopic drift along the field lines, possible amplification and absorption mechanisms for transverse waves propagating along the field lines were investigated with particular regard to frequencies near the proton cyclotron frequency. A search was made, notably, for frequency-selective effects that might account for the observations, in high latitudes, of narrow band emissions centered at approximately 700 c/s, which is close to the proton cyclotron frequency in the ionosphere. No such effects were found. The only e-l-f emissions which readily may be amplified in the exosphere are those of right-handed polarization. Streaming protons may cause the amplification. High-energy electrons, streaming along the magnetic field lines in a direction opposite to that of the wave propagation, may absorb such e-l-f emissions, though only if the refractive index conforms to highly restrictive desiderata, e-l-f emissions of left-handed polarization may be amplified by high-energy electrons. For this, however, the demands on the refractive index are such that it is questionable if amplification at frequencies close to the proton cyclotron frequency can take place anywhere in the ionosphere or the exosphere. On the other hand, such emissions will be readily absorbed by the protons existing in the exosphere and the ionosphere. From the theory applied in this study, it follows that instabilities caused by anisotropic temperatures possibly are factors in the generation of L-mode emissions at frequencies below the proton cyclotron frequency, in which case the protons will constitute the important factor. (auth)

**33149** EXCITATION OF ATMOSPHERIC HELIUM. McElroy, Michael B. (Kitt Peak National Observatory, Tuscon, Ariz.). Planetary Space Sci., 13: 403-33(May 1965).

The possible excitation mechanisms for triplet metastable helium in the upper atmosphere are considered in some detail. It is concluded that excitation by photoelectron impact is the most likely production mechanism. The results obtained are in satisfactory agreement with twilight observations at $\lambda = 10{,}830$ Å. Although electron recombination with helium ions is found to give negligible contribution to 10,830-Å emission, the expected variation in the abundance of helium ions through the solar cycle is examined. It is suggested that the atmosphere at solar minimum may contain appreciably less helium ions than it does at solar maximum. Attention is directed to the possible effects of the long mean free paths of 20-ev electrons pro-

duced above about 200 km. The present calculations, which do not include non-local effects, refer to low magnetic latitudes where electrons are constrained vertically by the horizontal field lines. Observations at different latitudes would be desirable and might provide valuable information on the importance of non-local effects. The diurnal variation of 10,830-Å emission is considered in some detail. It is concluded that little dayglow enhancement over twilight is to be expected. Indeed at solar minimum the noontime intensity may well be appreciably less than the twilight value. 81 references. (auth)

**33150** INVESTIGATION OF THE RADIATION BELTS IN THE REGION OF THE BRAZILIAN MAGNETIC ANOMALY. Vernov, S. N.; Nesterov, V. E.; Savenko, I. A.; Shavrin, P. I.; Sharvina, K. N. Planetary Space Sci., 13: 451-6(May 1965).

Translated by H. S. H. Massey from Kosmich. Issled., Akad. Nauk SSSR, 2: No. 3, p.485(1964).

The geographical distribution of the radiation intensity in the region of the Brazilian magnetic anomaly is given according to the data of the Kosmos-7 and Kosmos-15 satellites. The distribution obtained is compared with the results of measurements by the Kosmos-3 and Kosmos-5 satellites and the Discoverer-31 satellite. (auth)

**33151** IONOSPHERIC WINDS AND THE DISTRIBUTION OF CHARGED PARTICLES IN THE GEOMAGNETIC FIELD. Krassovskii, V. L. (Inst. of Physics of the Atmosphere, Moscow). Planetary Space Sci., 13: 469-70(May 1965).

The distribution of the charged particles trapped in the geomagnetic field is discussed on the basis of the inference by King-Hele that at altitudes of 200 to 300 km, winds blow in an eastern direction at speeds which may exceed $10^4$ cm/sec$^{-1}$. (D.C.W.)

**33152** A MECHANISM FOR THE INJECTION OF VERY LOW-ENERGY PARTICLES INTO THE MAGNETOSPHERE. Apparao, Krishna (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 61: 160-3(Mar. 1965).

A mechanism for the injection of very low energy particles into the magnetosphere is suggested. Protons in the solar plasma accelerate neutral hydrogen atoms in the interplanetary gas by charge exchange; these hydrogen atoms are stripped by the gas in the exosphere to give protons. The rate of such injection into the magnetosphere during a geomagnetic storm is calculated and is found to be about $10^{22}$ protons per second of energy ~20 kev. (auth)

**33153** MODEL EXPERIMENT AND NATURAL PHENOMENON OF INTERACTION OF SOLAR PLASMA STREAM WITH GEOMAGNETIC FIELD. Fukushima, Naoshi (Tokyo Univ.); and Kawashima, Nobuki. Rept. Ionosphere Space Res. Japan, 18: 377-93(Dec. 1964).

The experimental results for the interaction of a plasma stream with a dipole magnetic field are examined in detail to discuss the extent to which laboratory experiment can simulate the natural phenomenon of the solar wind—geomagnetic field interaction. The solar stream is a typical low density plasma, while the laboratory plasma is of rather medium density. From this fundamental difference, the diffusion of plasma across the magnetic cavity boundary is appreciable in a short time in the model experiment. When a plasma containing heavy ions is used in the experiment, the space inside the magnetic cavity on the upstream side of the model earth becomes rather uniformly bright in the time-exposure photographs, owing to the fast diffusion of such a plasma across the magnetic field. On the rear side of the model earth near the equator, where an intense westward electric current can be detected in the experiment, the charged particles are drifting in the inhomogeneous magnetic field. Most of these particles seem to have penetrated into the magnetic cavity from around the cusp of the cavity boundary, i.e. the neutral point of the magnetic field on the upstream side of the earth, in the model experiment. In the natural phenomenon of the penetration of charged particles contained in the solar wind into the geomagnetic cavity, the penetration from both the dawn and evening sides of the earth may be operative, in addition to the impinging of particles from the neutral points in high latitudes of the geomagnetic cavity. (auth)

**33154** LOW-FREQUENCY ELECTROMAGNETIC OSCILLATIONS OF THE EARTH-IONOSPHERE CAVITY. Madden, T. (Massachusetts Inst. of Tech., Cambridge); Thompson, W. Rev. Geophys., 3: 211-54(May 1964).

The observational and theoretical work on the low-frequency electromagnetic oscillations of the earth-ionosphere cavity, known as the Schumann resonances, is reviewed. Additional theoretical considerations are introduced to allow the models to incorporate the asymmetries of the actual cavity. These models are used to explain the observed variations of the power and of the apparent frequency of the resonant modes. The theoretical studies show that the structure of the low D or C region of the ionosphere is critical to these resonances, and the observed frequencies must rule out certain proposed ionospheric models. The perturbations of the cavity are also studied, and comparisons are made between different types of perturbations. The resonance data from July 9, 1962, are used to confirm the tremendous extent of the ionospheric perturbations caused by the Starfish high-altitude nuclear explosion. The possible effects of natural perturbations are also examined. (auth)

**33155** TRAPPED ORBITS IN A MAGNETIC DIPOLE FIELD. Dragt, A. J. (Inst. for Advanced Study, Princeton, N. J.). Rev. Geophys., 3: 255-98(May 1964).

A review is given of the trapped motion of a charged particle in a dipole magnetic field. An extensive discussion is presented of the equations of motion in various coordinate systems and of their solution by approximate and analytically exact methods. Wherever possible, approximate solutions are compared with exact solutions obtained by numerical integration. (auth)

**33156** ATMOSPHERIC NOBLE GASES: SOLAR-WIND BOMBARDMENT OF EXTRATERRESTRIAL DUST AS A POSSIBLE SOURCE MECHANISM. Tilles, David (Harvard Coll., Cambridge, Mass.). Science, 148: 1085-8 (May 21, 1965).

A source mechanism for the noble gases in the earth's atmosphere may be the solar-wind bombardment of extraterrestrial dust. Calculations based on estimates of recent influx of dust to the earth, quiet solar-wind intensity, argon abundance in the solar wind, and assumed Poynting-Robertson lifetimes of small particles in space agree within a factor of 5 with the present amounts of argon-36 and argon-38 in the atmosphere. (auth)

## Low Temperature Physics

*Refer also to abstract 32511.*

**33157** FLUX BUNDLE PENETRATION INTO SUPERCONDUCTING INDIUM DISKS. Baird, D. C. (Royal Military Coll., Kingston, Ont.). Can. J. Phys., 43: 971-2(May 1965).

Photographs are presented illustrating the penetration of magnetic flux into superconducting In disks of 99.999% purity. The formation of flux bundles at the tips of the peripheral flux fingers and the disintegration of the tips of the fingers are shown. (M.J.T.)

**33158** A HYDROGEN LIQUEFIER WITH TWO-STAGE CONVERSION TO OBTAIN 98 PER CENT PARAHYDROGEN. Fradkov, A. B.; Troitskii, V. F. Cryogenics, 5: 136-7(June 1965).

The circuit and construction of a liquefier to obtain 98 per cent parahydrogen is described; it is based on the production equipment of the VOS-3 liquid hydrogen plant. The refrigeration cycle works on the Joule-Thomson effect with normal hydrogen. Parahydrogen is obtained in a separate cycle by conversion at two temperature levels—at liquid nitrogen temperature (in the gaseous phase) and at liquid hydrogen temperature. The installation has been in normal operation since 1961. (auth)

**33159** EFFECT OF RATE OF CHANGE OF MAGNETIC FIELDS AND TEMPERATURE ON FLUX JUMP IN $Nb_3Sn$ HOLLOW CYLINDERS. Lange, F. Cryogenics, 5: 143-5 (June 1965).

Studies were made with $Nb_3Sn$ hollow cylinders in the liquid hydrogen and helium temperature ranges in an axial magnetic field under different rates of change or, in the case of trapped magnetic fields, under different rates of heating. The tendency to jump has been found to increase with the current density which is affected by quality, temperature, and magnetic field. The tendency to jump also increases with the rate of change of field and with the rate of heating. When using porous samples, the tendency to jump decreases strongly in the helium II range. Consequently, in this temperature range, and with a slowly changing field, "critical state curves" are obtained allowing the highest possible fields to be trapped. For very rapid field changes, jumps also occur in the helium II range. Therefore, for trapping a given field, no higher field need be available, since by switching on field $H_a$ rapidly, a point on the $H_i = H_a$ line can be reached directly in a flux jump. (auth)

**33160** HEAT TRANSFER AT LOW TEMPERATURES. Dorey, A. P. Cryogenics, 5: 146-51 (June 1965).

A series of experiments were conducted to evaluate the thermal parameters needed in the analysis of heat flow in thin film cryotron circuits at low temperatures. The results may be divided into two categories dealing with heat flow from solids to liquid helium and between solids. Between solids and liquid helium convection processes are responsible for the heat transfer and theoretical explanation is given for some of the results. In the case of heat flow between solids the acoustic mismatch between the solids causes a temperature discontinuity and the measured results are compared with the theoretically expected values. (auth)

**33161** PROGRESS IN THE DEVELOPMENT OF SUPERCONDUCTING MAGNETS. Laverick, C. Cryogenics, 5: 152-8 (June 1965).

Large superconducting coil systems are feasible and drastic reductions in the cost of large systems, using currently available materials, can be expected. The properties of some of these materials are mentioned and magnet design criteria are suggested. A number of recently constructed magnets which are of significance to this developing technology are discussed as are some of the coil effects. The characteristics of superconducting cable and of magnets made from this material are described. (auth)

**33162** A SIMPLE HELIUM-3 CRYOSTAT FOR SPECIFIC HEAT MEASUREMENTS BETWEEN 0.4 AND 4.2°K. Scurlock, R. G.; Wray, E. M. (Univ. of Southampton, Eng.). J. Sci. Instr., 42: 421-4 (June 1965).

The design and construction of a $^3He$ cryostat suitable for specific heat measurements between 0.4 and 4.2°K are described. The $^3He$ system has been simplified by the elimination of a backing pump and requires only 500 $cm^3$ of gas. The cryostat also incorporates a mechanical heat switch. (auth)

**33163** ON SINGLE PARTICLE EXCITATIONS IN THE MIXED STATE OF A TYPE II SUPERCONDUCTOR. Canel, E. (Univ. of Birmingham, Eng.). Phys. Letters, 16: 101-3 (May 15, 1965).

The nature of the one particle excitations for the case of a vortex array for type II superconductors is considered. Calculations of the positive eigenvalues of the system are outlined, and it is found within the framework of a tight binding calculation that the excitations have proper ties reminiscent of those of an electron moving in a periodic lattice and external magnetic field. The results suggest that the one particle excitations behave like Bloch electrons, and thus should contribute to the thermal conductivity, the electromagnetic response, and ultrasonic attenuation of the system. (L.B.S.)

**33164** FLUX JIMPING IN Nb–25% Zr UNDER NEARLY ADIABATIC CONDITIONS. Wipf, S. L.; Lubell, M. S. (Westinghouse Research Labs., Pittsburgh). Phys. Letters, 16: 103-5 (May 15, 1965).

The flux jump behavior of solid cylinders of cold drawn Nb–25% Zr was investigated. The field at which the first flux jump occurred was observed to be a function of the time rate of field increase dH/dt. It is shown that the temperature rise associated with flux motion causes a flux jump, assuming adiabatic conditions. The calculated value of the upper critical field was found to be in reasonable agreement with the observed value in the limit of very high dH/dt. The calculated temperature rise was also experimentally verified, using a carbon resistance thermometer. (L.B.S.)

**33165** EVIDENCE FOR A λ-TRANSITION AT THE LOWER CRITICAL FIELD IN TYPE II SUPERCONDUCTORS. Serin, B. (Rutgers State Univ., New Brunswick, N. J.). Phys. Letters, 16: 112-13 (May 15, 1965).

Magnetization measurements were made on niobium wires as a function of the ratio of the applied field to the lower critical field, and the results of detailed measurements between 0.97 $H_{c1}$ and 1.05 $H_{c1}$ were studied. The data were found to be continuous in this region and show evidence of a very large slope in the neighborhood of the field chosen as the critical field. The data at fields greater than $H_{c1}$ are shown in a semilogarithmic plot as a function of $H_{c1}/B$, where B is the magnetic induction. It is concluded that if the induction has a logarithmically singular slope at $H_{c1}$, the specific heat at this temperature should exhibit a λ-point. (L.B.S.)

**33166** THE SIZE EFFECT IN THE MAGNETIZATION OF TYPE II SUPERCONDUCTORS. Evetts, J. E.; Dew-Hughes, D.; Campbell, A. M. (Cambridge Univ., Eng.). Phys. Letters, 16: 113-14 (May 15, 1965).

Theoretical magnetization curves were computed for Pb–Bi superconductors taking into account the variation of pinning strength with the field for a range of values of the composition parameter, $a\alpha$. Pb–Bi specimens were prepared with a constant microstructure and a range of diameters, and magnetization measurements were made. Values of the composition parameters, which were obtained from the magnetization curves, were plotted against the specimen diameter to the test the sign effect which predicts a straight line through the origin. Good agreement was found. (L.B.S.)

**33167** VIBRATING IONS IN LIQUID He II. Cope, J. A.; Gribbon, P. W. F. (Univ. of St. Andrews, Fife, Scotland, U. K.). Phys. Letters, 16: 128-30 (May 15, 1965).

The difficulties contained in the model suggested by Careri et al. for the periodic discontinuities in the mobilities of positive and negative ions in liquid helium II are outlined. An alternative suggestion that the periodic discontinuities are associated with the excitation of quantized vibrational energy state of the ion is offered. The model explains the periodic nature of the discontinuities, the difference between critical velocities for the positive and negative ions, and predicts the giant discontinuity for positive and negative ions at $v = 25$ to 30 m $sec^{-1}$. (L.B.S.)

**33168** ON THE NATURE OF RESISTANCE IN THE MIXED STATE OF TYPE II SUPERCONDUCTORS. Pearl, J. (RCA Labs., Princeton, N. J.). Phys. Letters, 17: 12-14 (June 15, 1965).

An experiment is proposed to prove or disprove two theories on type II superconductors. The first theory is that transport current passing through a superconductor in the mixed state can cause motion of flux lines perpendicular to the current flow. The other theory is that a continuous motion of flux lines produces a steady potential difference across the superconductor perpendicular to the flux motion. Since there is no present experimental evidence of such a motion of flux lines the proposed experiment seeks to demonstrate whether such a phenomenon exists. (J.F.P.)

**33169** CRITICAL ALTERNATING CURRENTS IN SUPERCONDUCTING NIOBIUM STRIPS. Linford, R. M. F. (B.I.C.C., London). Phys. Letters, 17: 18-19 (June 15, 1965).

Critical alternating currents of niobium strips at 4.2°K were investigated over a range of frequencies. The effect of strip thickness on the variation of potential difference with current was discussed. The effect on the critical current by varying the frequency was shown to be constant for thinner strips but peaks for thicker strips were found. Various explanations such as the London dissipation are given to account for the shape of the curves. (J.F.P.)

**33170** COMPTON WAVELENGTH OF SUPERCONDUCTING ELECTRONS. Zimmerman, J. E.; Mercereau, J. E. (Ford Motor Co., Dearborn, Mich.). Phys. Rev. Letters, 14: 887-8(May 31, 1965).

Experiments demonstrating macroscopic quantum effects in superconductors are discussed. These experiments provide a direct measurement of the quantum of circulation, h/m, for superconducting electrons, and thus the Compton wavelength, h/mc. (M.O.W.)

**33171** MOTION OF SUSPENDED PARTICLES IN TURBULENT SUPERFLOW OF LIQUID HELIUM II. Chung, David Y.; Critchlow, P. R. (Univ. of British Columbia, Vancouver). Phys. Rev. Letters, 14: 892-4 (May 31, 1965).

An experiment for measuring the motion of suspended particles in pure superflow of liquid He II is discussed. A calibration curve of the average superfluid velocity against power input shows that below a certain power input the velocity is linearly proportional to power and at higher powers the curve flattens out. Particles produced by solidifying a mixture of hydrogen and deuterium were used. (M.O.W.)

**33172** DETECTION OF THE ac JOSEPHSON EFFECT. Giaever, Ivar (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. Letters, 14: 904-6(May 31, 1965).

An experiment is described for the detection of the electromagnetic fields in a tunnel junction operating in the a-c Josephson mode. Diagrams illustrating the current-voltage characteristics of the generator and detector are included. The experimental arrangement, which makes use of a tin tunnel junction, is described. (M.O.W.)

**33173** PHASE COHERENCE AND STABILITY OF HELIUM II IN NARROW CHANNELS. Donnelly, R. J. (Univ. of Chicago). Phys. Rev. Letters, 14: 939-42(June 7, 1965).

A study of the flow of superfluid through narrow channels is presented. A three-bath experiment with helium II describes the superfluid flow. A direct analogy is made to the a-c and d-c Josephson effects. The film junction has the property that the phase is coherent throughout. (M.O.W.)

**33174** FLOW VISUALIZATION IN He II: DIRECT OBSERVATION OF HELMHOLTZ FLOW. Kitchens, T. A. (Los Alamos Scientific Lab., N. Mex.); Steyert, W. A.; Taylor, R. D.; Craig, Paul P. Phys. Rev. Letters, 14: 942-5(June 7, 1965).

Perfect potential flow of helium II about obstacles, such as Rayleigh disks and airfoils is investigated. Experiments verifying flow separation of the type discovered by Helmholtz are included. Verification is made by a direct observation of the motion of particles of frozen H-D gas about obstacles placed in a bath of rotating helium II. (M.O.W.)

**33175** SUPERCONDUCTING TRANSITION TEMPERATURE OF THIN FILMS. Strongin, Myron; Kammerer, O. F.; Paskin, Arthur (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 949-51(June 7, 1965). (BNL-9137)

Superconducting transition temperatures ($T_c$) of thin aluminum and other metal films with their edges trimmed are investigated. The transition temperature increases as film thickness decreases. A comparison of the experimental and theoretical variation of $T_c$ with the total film thickness is made. (M.O.W.)

**33176** SURFACE SUPERCONDUCTIVITY AND MEAN FREE PATH. Silvert, William (Michigan State Univ., East Lansing). Phys. Rev. Letters, 14: 951-2(June 7, 1965).

The consequences of a previous suggestion that surface superconductivity in very thin films may be enhanced by contact with a dielectric, e.g. oxide layer, which can be polarized to give an attractive electron-electron interaction at the surface are discussed. The integral equation representing the energy gap function at the critical temperature as a function of electron mean free path and film thickness is given. (M.O.W.)

**33177** SUPERCONDUCTING LANTHANUM CHALCOGENIDES. Bozorth, R. M.; Holtzberg, F.; Methfessel S.; (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev. Letters, 14: 952-3(June 7, 1965).

Compounds $La_3Se_4$ and $La_3S_4$ are reported to be superconducting below 8.6°K and 6.5°K, respectively. A study of the effect of magnetism on superconductivity as a function of various lanthanum concentrations is presented. Hysteresis loops of $La_3S_4$ and $La_3Se_4$ at 1.3 and 1.25°K, respectively, are included. (M.O.W.)

**33178** QUANTIZED VORTICES AND THE SUPERFLUID HELIUM ANALOG OF THE ac JOSEPHSON EFFECT. Zimmermann, W., Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters, 14: 976-9(June 14, 1965).

The equation used previously for relating an effect in superfluid to the a-c Josephson effect in superconductors is derived. This equation was previously derived using the concept of a complex order parameter for the liquid. It is now derived from the conventional equations of the two fluid hydrodynamics combined with the assumption of quantization of vorticity in the superfluid. (M.O.W.)

**33179** SHEAR WAVES IN SOLID $He^4$. Lipschultz, F. P.; Lee, D. M. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 14: 1017-19(June 21, 1965).

Measurements are reported on the velocity of 10-Mc transverse sound waves in both the body-centered cubic (bcc) and hexagonal close-packed (hcp) phases of solid $^4$He. The velocity in the bcc phase is 347 m/sec and appears to be nearly isotropic, while the velocity in the hcp phase varies between 230 and 315 m/sec at about 25.6 atm, indicating a high degree of anisotropy. (M.O.W.)

**33180** EVIDENCE FOR TWO ENERGY GAPS IN HIGH-PURITY SUPERCONDUCTING Nb, Ta, AND V. Yun Lung Shen, Lawrence; Senozan, N. M.; Phillips, Norman E. (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 1025-7(June 21, 1965).

Heat-capacity measurements on zone-refined single-crystal samples of Nb, Ta, and V between 0.35 and 25°K are presented. Results indicate that at temperatures below about Tc/10, the superconducting electronic heat capacity $C_{es}$ is considerably larger than that predicted previously, and its temperature dependence does not correspond to previous reports. The data can not be explained by energy-gap anisotropy of the usual magnitude. They are explained by the existence of two distinct energy gaps reported previously. (M.O.W.)

**33181** CRITICAL MAGNETIC FIELD OF SECOND GROUP SUPERCONDUCTOR. Li, Huan-chen. Wu Li Hsueh Pao, 21: 560-8(Mar. 1965). (In Chinese)

The paramagnetic energy in the theory of Ginzburg and Landau is introduced. The formula obtained for the critical magnetic field of a type-II superconductor coincides with experimental data for the Ti–V alloy system. It is shown that the transition from the mixed state into the normal state remains a phase transition of the second kind; near the transition point the magnetic moment is proportional to $(H_k - H)$; during the transition on the discontinuity of the heat capacity in a strong magnetic field has values of the same order as in zero magnetic field. These results agree well with experimental data on the heat capacity of $V_3Ga$ and the magnetic moment of $Nb_3Sn$. (tr-auth)

**33182** ON THE VORTEX STRUCTURE OF ROTATING HELIUM. Kiknadze, L. V.; Mamaladze, Yu. G.;

Cheishvili, O. D. (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Eksperim. i Teor. Fiz., 48: 1520-5 (May 1965). (In Russian)

It is shown that two-dimensional vortex lattices in rotating liquid helium are capable of rotating along with the vessel. It is also shown that regions of reverse rotation of the superfluid liquid exist in the intervortex volume (in a rotating reference system). (auth)

**33183** THERMOELECTRIC REFRIGERATION. Goldsmid, H. J. The International Cryogenics Monograph Series. New York, Plenum Press, 1964. 249p. $11.50.

The physical and engineering aspects of thermoelectric refrigeration are covered from the basic principles through the physics of thermoelectric materials to the engineering of thermoelectric cooling units. Practical problems encountered in research and development laboratories are presented, e.g., the measurement of thermoelectric parameters, the optimization of materials, and the design of cooling units in real rather than ideal situations. In addition, the subject of Ettinghausen (thermomagnetic) refrigeration is covered, particularly with reference to cooling at very low temperatures. Bismuth-antimony alloys are also discussed. (L.B.S.)

**33184** SUPERCONDUCTIVE DEVICE. Swartz, Paul S. (to General Electric Co.). U. S. Patent 3,158,794. Nov. 24, 1964. Filed June 8, 1962.

A high field superconductive device includes an insulated container and a high field superconductive solenoid positioned in the container. The solenoid is coated with a non-superconducting material and has an aperture. Means are provided to produce a magnetic field generally parallel to the axis of the aperture substantially within the walls of the aperture. Coolant in the container contacts the exterior walls of the solenoid to maintain the temperature of the solenoid below its critical temperature. A second high field superconductive member maintained at a temperature below its critical temperature is adapted to be inserted into the aperture of the solenoid for compressing variably the magnetic field. (B.L.M.)

**33185** SUPERCONDUCTIVE MATERIALS. Treaftis, Harry N.; Watts, Charles E. Jr.; Meyer, Raymond A. (to General Electric Co.). U. S. Patent 3,169,859. Feb. 16, 1965. Filed Mar. 27, 1962.

Superconductive materials useful for joining together superconductive elements consist of mixtures of Ga with In, Sn, or In-Sn alloy. The materials are semifluid at room temperature and may be applied without application of heat; they become rigid at lower temperatures. The materials may also be used as superconductive elements themselves by coating the material in any convenient way on a suitable base. (A.G.W.)

**33186** SUPERCONDUCTIVE DEVICE. Swartz, Paul S. (to General Electric Co.). U. S. Patent 3,174,083. Mar. 16, 1965. Filed June 14, 1962.

A high-field superconductive device having a greater length than diameter consists of a stack of high-field superconducting members. Each member has an aperture through it so formed that, when the members are stacked, the aperture is continuous. Means are provided for maintaining the temperature of the members below their critical temperatures. (A.G.W.)

**33187** SUPERCONDUCTORS AND METHOD FOR THE PREPARATION THEREOF. Denny, John P.; Hardt, Richard W. (to General Electric Co.). U. S. Patent 3,183,936. May 4, 1965. Filed Dec. 30, 1960.

A method is described for the preparation of an improved superconductor in the form of a slab, wire, or strip. A base metal body having superconductivity characteristics is contacted with Nb and a second metal from the group of Sn, Ga, and Al in an atmosphere substantially nonreactive with Nb and the second metal at an elevated temperature at least as high as the melting point of the second metal. The reaction conditions are maintained until Nb and the second metal react to form in situ a crystalline reaction product having superconductivity characteristics. (B.L.M.)

# Neutron Physics

## See also REACTOR TECHNOLOGY — Criticality Studies.

*Refer also to abstract 31930.*

**33188** (AAEC/TM-288) ABSOLUTE CALIBRATION OF RADIOACTIVE NEUTRON SOURCES. Davy, D. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1965. 16p. Dep.(mn).

The techniques used at Lucas Heights for the calibration of radioactive neutron sources by the manganese sulfate bath method are described. For strong sources ($Q > 10^6$ n/sec), a 100-cm diameter tank and a 2 in. × 2 in. NaI(Tl) dip counter are used; for weaker sources, a 30 cm diameter spherical volume of solution about the source is isolated from the bulk of the bath during irradiation, using a rubber balloon, and the specific activity of the irradiated manganese sulfate from within and without the balloon measured with a low background 8 in. × 4 in. NaI(Tl) crystal. Ra($\alpha$,n)Be and Pu($\alpha$,n)Be sources with emission rates between $10^4$ n/sec and $2 \times 10^7$ n/sec have been calibrated in this way with an estimated absolute error of ±2.3%. The major part of this is due to a 2.0% error in the $4\pi\beta$-$\gamma$ standardization of the $^{56}$Mn activity used to calibrate the detectors; relative error is estimated at less than 1%. In the case of Pu($\alpha$,n)Be sources, allowance is made for neutron multiplication within the source when it is immersed in the bath. (auth)

**33189** (AP-Note-426) NOTES ON PLACZEK'S THEOREM $P_0 = \rho_{AV}/\rho_\infty$. Murray, R. L. (Alco Products, Inc., Schenectady, N. Y. Nuclear Power Engineering Dept.). June 20, 1962. Contract AT(30-1)-2639. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A neutron-absorbing sphere in an infinite sea of uniform-density neutrons having anisotropic flux distributions is considered. The theorem $P_0 = \varphi$ (average)/$\varphi$ (infinity) is investigated, where $P_0$ is the average first-flight escape probability for neutrons starting from points uniformly distributed within the sphere, $\varphi$ (average) is the average neutron flux within the sphere, and $\varphi$ (infinity) is the unperturbed value of the neutron flux. The results of the use of the theorem are compared with the results of Amouyal-Benoist diffusion methods. (T.F.H.)

**33190** (CEA-R-2614) ASPECTS THEORIQUES DE L'INTERACTION NEUTRONIQUE. ANNEXE I. PROGRAMME D'INTERACTION POUR IBM 7094. ANNEXE II. SOUS PROGRAMME OMBRE. (Theoretical Aspects of Neutron Interaction. Moret-Bailly, Jean. Appendix I. Interaction Program for IBM 7094. Moret-Bailly, Jean. Appendix II. The Shielding Sub-Program.) Penet, Francois; Spinelli, Jean-Claude (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1965. 121p. Dep.(mn).

Methods are described for obtaining the equations for a system of elements containing fissile matter by using the balance after fission, by using the balance before fission, and by the evolution equations. All these methods lead to equivalent matrices whose greatest eigenvalue is the multiplication coefficient for the system K. It is shown how to calculate K. From this it is possible to deduce the rules which generalize the criterion for the bounded solid angle. An IBM 7094 program applies this theory to the calculation of the installations made up of a maximum of 500 elements. It calculates the effective values of K, the leakage, the solid angles, and K. (auth)

**33191** (EUR-2294.e) CODE FIRST I — IBM 7090 FORTRAN II CODE FOR THE CALCULATION OF A NEUTRON SPECTRUM FOR A HETEROGENEOUS LATTICE. Takahashi, H.; de Wolde, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center and European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). 1965. 23p. Dep.(mn).

The code FIRST performs the calculation of thermal neutron spectra in a cylindrical cell system by using the first flight collision probability method. The system is composed of regions, for example fuel, moderator, and coolant. The regions are divided into subregions, and the first flight collision probabilities in these subregions are calculated for each energy group. The simultaneous equation for the fluxes in subregions is solved by the iteration method. (auth)

**33192** (GA-6096) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending, December 31, 1964. Beyster, J. R.; Koppel, J. U.; Naliboff, Y. D.; Neill, J. M.; Russell, J. L., Jr.; Young, J. A.; Young, J. C. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Jan. 28, 1965. Contract AT(04-3)-167. 78p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Experimental and theoretical studies are reported on: infinite-medium neutron spectra in borated light water; comparisons of measured and integral and $S_n$ transport-theoretical neutron spectra in U–$H_2O$ systems; the differential scattering cross sections of V and $H_2O$ for 0.001- to 1-ev neutrons; neutron spectra in Fe–polyethylene and polyethylene–borated polyethylene cells; neutron coherent scattering by $D_2O$ at 0.04 to 0.1 ev; neutron scattering by polyethylene at 0.2 to 0.4 ev; the neutron scattering law of Be; neutron scattering law calculations as functions of scatterer atomic weight; the scattering law code GASKET; and the coherent elastic scattering code HEXSCAT for hexagonal lattices. (T.F.H.)

**33193** (MND-C-2933) PLMC-1, NEUTRON MONTE CARLO CODE FOR SLAB GEOMETRY. Kniedler, Mark; Jordan, Thomas (Martin Co., Baltimore). [nd]. 116p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

PLMCN-1 is a multi-region, multi-energy-group, time-dependent Monte Carlo code for neutrons in a homogeneous medium where the neutron interactions considered include only scattering and absorption. It is coded in Fortran II for the IBM 7090. (T.F.H.)

**33194** (N64-18279) CALCULATION OF SLOW NEUTRON SCATTERING CROSS SECTIONS OF MOLECULAR HYDROGEN AND DEUTERIUM. Young, James A.; Koppel, Juan U. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Dec. 20, 1963. Contract NAS 3-4214. 45p. (NASA-CR-54001; GA-4828). $4.60(CFSTI).

The cross sections for neutrons scattering from $H_2$ and $D_2$ were calculated taking into account the spin correlations, rotations, and vibrations of the molecules exactly, to the extent that the vibrations are harmonic and do not interact with the rotations. Free translations of the molecules are assumed, but this assumption is expected to be valid in the liquid for neutron energies above 0.002 ev. Numerical results are given for the total cross section for both orthohydrogen and parahydrogen gas at 20.4°K, which agree reasonably well with the limited experimental results available. Also curves of the double differential cross section are shown for selected incident neutron energies and scattering angles. These latter curves show very clearly the various rotational and vibrational transitions. The formulas given are applicable at all temperatures below the thermal excitation of the first vibrational level. (auth)

**33195** (NAA-SR-Memo-9202) NAA PROGRAM DESCRIPTION—$S_4$ CYLINDRICAL GEOMETRY CELL CODE. Temple, Joanne S.; Blaine, R. A. (Atomics International, Canoga Park, Calif.). Nov. 1963. Contract AT-11-1-GEN-8. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

This program is a modification of the original $S_n$ Cylindrical Cell, N Regions, program written by General Atomic, a Division of General Dynamics Corporation. For further information, the reader should refer to the program description in the General Atomic publication, $S_n$ 1 Cylindrical Cell, N Regions (C), GA-360. (auth)

**33196** (NIJS-R-435) THE ASYMPTOTIC ANGULAR DEPENDENT LEAKAGE SPECTRUM OF THERMAL NEUTRONS. Kladnik, R. (Nuklearni Institut "Jozef Stefan," Ljubljana (Yugoslavia)). Aug. 1964. 19p. Dep.(mn).

The application of the variational method in velocity-dependent transport theory is described for the case of a pulsed infinite slab. The extrapolated endpoint and the buckling as functions of the slab thickness are calculated from a given transcendental equation. The expression for the angular and energy distribution of leakage neutrons is improved by one iteration of the integral transport equation. The results are discussed for three different scattering models: monatomic gas, Nelkin water, and the Egelstaff model. It is found that Nelkin's model gives a better estimate for the integral constants, whereas the Egelstaff's law is more suitable for the differential spectrum calculations. (auth)

**33197** (NIJS-R-437) EXPERIMENTAL VERIFICATION OF A REMOVAL AGE-DIFFUSION MULTIGROUP PROGRAM IN A THERMAL COLUMN. Zerdin, F.; Dimic, V. (Nuklearni Institut "Jozef Stefan," Ljubljana (Yugoslavia)). Sept. 1964. 7p. Dep.(mn).

A removal age-diffusion multigroup program, with only four energy intervals in the removal group, for a bulk shield was experimentally verified in the thermal column of the 6.5-Mw heavy-water experimental reactor in Vinča. Thermal and epithermal neutron fluxes were measured using bare and cadmium-covered Au and In foils. The measured cadmium ratio is accurate in the high flux region close to the reactor core. In the low flux region the experimental accuracy was not sufficient to get reliable results. The measured and calculated values of $R_{Cd}$ are not in good agreement. The relative values of the calculated and measured thermal fluxes agree satisfactorily throughout the thermal column, except at the outer face. The absolute values disagree due to normalization uncertainties. (auth)

**33198** MORE NEUTRONS, HIGHER FLUX SPELLING. Can. Chem. Process., 48: No. 12, 47-8; 50(Dec. 1964).

The neutron generator under consideration at Chalk River is discussed in which the excitation of heavy nuclei by charged particle with subsequent fission would provide fluxes, perferably on the order of $10^{16}$ $cm^{-2}sec^{-1}$. The costs of such an installation are considered, together with some engineering problems. (D.C.W.)

**33199** EXISTENCE AND UNIQUENESS THEOREMS IN INVARIANT IMBEDDING. I. CONSERVATION PRINCIPLES. Bellman, R.; Cooke, K. L.; Kalaba, R.; Wing, G. M. (RAND Corp., Santa Monica, Calif.). J. Math. Anal. Appl., 10: 234-44(Apr. 1965).

Neutron transport in a one-dimensional, homogeneous, isotropic rod extending along an axis from z = o to x is treated using the theory of invariant imbedding. It is assumed that there is a finite number of different types of particles moving along the rod; these possible states are taken to be energy levels. The Riccati differential equations for the absorption, reflection, and transmission matrices are derived using invariant imbedding techniques. The existence and uniqueness of the solutions of the equations for $x \geq 0$ are established, together with the conservation relation satisfied by the solution. (D.C.W.)

**33200** SPACE-TIME CORRELATIONS IN NEUTRON DISTRIBUTIONS IN A MULTIPLYING MEDIUM. Otsuka, Masuhiko; Saito, Keiichi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 191-8 (May 1965).

For reactors without feed-back, the space-time correlation function in neutron distributions is obtained in a continuous phase space. The stationary process was investigated in detail. Applicability of the Langevin equation was also examined. (auth)

**33201** MEASUREMENT OF RESONANCE NEUTRON FLUX BY SELF-SHIELDING METHOD. Yamamoto, Hisashi (Hitachi Central Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 199(May 1965).

Since self-shielding factors of a resonance foil depend sensitively on its thickness as well as on resonance param-

eters, the reaction rates due to the resonance absorption and to the 1/V absorption were obtained separately. An example of the method is given. (P.C.H.)

**33202** APPROXIMATION FOR TAKING SCATTERING ANISOTROPY INTO ACCOUNT IN INTEGRAL TRANSPORT THEORY. Meyer, K. (VEB Atomkraftwerk, Berlin). Kernenergie, 8: 209-15(Apr. 1965). (In German)

Possibilities are studied for taking the scattering anisotropy in neutron flux calculations into account as a function of energy in a Wigner-Seitz cell. As is shown neglect of anisotropy only gives rise to small errors in $f$ when the cell dimensions are sufficiently small, but the influence of scattering anisotropy on flux depression cannot be neglected. (auth)

**33203** NEUTRON-WAVE PROPAGATION USING THE $P_1$ APPROXIMATION. Mortensen, Glen A.; Smith, Harold P., Jr. (Univ. of California, Berkeley). Nucl. Sci. Eng., 22: 321-7(July 1965).

The time-dependent $P_1$ approximation to the neutron transport equation was solved for the case of an oscillating source on one face of a finite parallelepiped. An oscillatory solution to the differential equations describes the propagation of neutron waves through the medium. Attenuation lengths of plane neutron waves were identical at low frequencies ($\omega < \frac{1}{2}v\Sigma_a$) for the $P_1$ and diffusion approximations, but differ considerably at high frequencies ($\omega > 2v\Sigma_{tr}$). Wave lengths and wave speeds for the two approximations were slightly different at low frequencies, identical at immediate frequencies, and considerably different at high frequencies. A new method, which considers the transient behavior of a spatially integrated positive-definite function of flux and current, is used to show that the transient part of the solution decays to zero. (auth)

**33204** AN ASYMPTOTICALLY CORRECT APPROXIMATION TO THE MULTIDIMENSIONAL TRANSPORT EQUATION. Pomraning, G. C. (General Atomics Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 22: 328-38(July 1965).

An approximation to the transport equation is presented, which is capable of arbitrary accuracy and yields the exact transport-theory asymptotic behavior in all orders for any geometry. Anisotropic scattering is treated explicitly, and the inclusion of energy and time dependence is straightforward. The approximation, which is very similar to the usual spherical-harmonic ($P_N$) method, is derived by introducing a new truncation scheme into the infinite set of spherical-harmonic equations. This truncation method consists of assuming that the higher spherical-harmonic components, equated to zero in the $P_N$ method, can be related to lower components by assuming the angular distribution to be in an asymptotic distribution. The resulting approximation is very similar in structure to the $P_N$ approximation (in particular, it is no more complex), but has the added advantage of yielding exact asymptotic behavior. (auth)

**33205** REFLECTION AND TRANSMISSION BY A STRONGLY ABSORBING SLAB. Mockel, Andre (Universite Libre, Brussels). Nucl. Sci. Eng., 22: 339-49 (July 1965).

The reflection and transmission of monoenergetic particles with a known ingoing distribution by a strongly absorbing slab is studied from the numerical standpoint. Various approximation methods based on known theoretical solutions are presented. An approximation based on Chandrasekhar X and Y functions is proposed, and the reflection and transmission are obtained by using a variational technique. It is shown that a successive-collision technique gives identical results. A diffusion-like approximation, with adjusted coefficients, is also proposed. (auth)

**33206** EQUILIBRIUM SPECTRA AND DIFFUSION LENGTHS OF NEUTRONS IN SEMI-INFINITE MODERATOR BLOCK. PART I. Grover, P. S.; Kothari, L. S. (Univ. of Delhi). Nucl. Sci. Eng., 22: 366-72(July 1965).

Asymptotic neutron energy spectra inside a semi-infinite beryllium block were calculated by an iteration procedure using for the scattering kernel both the one-phonon scattering cross section and the first term of the Placzek expansion. Different absorptions were considered. The values of the transport mean free path, $\lambda_{tr}(E)$, were taken from Bhandari's work. Because of the sudden large variation of $\lambda_{tr}(E)$ near the Bragg cutoff, the calculated equilibrium flux differs markedly from the Maxwellian, particularly for high moderator absorptions. For a pure beryllium block at room temperature ($\sigma_a = 0.01$ barn), the deviation from the Maxwellian is small. Calculations also give the values of the diffusion length at different absorptions, from which data the diffusion constant $D_0$ and the diffusion cooling constant C were evaluated. (auth)

**33207** ON THE INCLUSION OF BOUNDARY TERMS IN TIME-DEPENDENT SYNTHESIS TECHNIQUES. Becker, Martin (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 22: 385-6(July 1965).

In connection with the application of synthesis techniques to various time-dependent problems, a variational principle was previously presented for linear time-dependent group-diffusion theory. However, the principle is not stationary with respect to arbitrary variations in the functions involved. It is shown that this difficulty can be avoided by inclusion of appropriate boundary terms in the functional. (D.C.W.)

**33208** INTERMEDIATE RESONANCE ABSORPTION AT LOW ENERGIES. Goldstein, Rubin (Univ. of California, Berkeley). Nucl. Sci. Eng., 22: 387-9(July 1965).

An intermediate resonance (IR) approach is outlined for the case of a spatially independent homogeneous mixture of a nonabsorbing moderator and a resonance absorber. Resonance integrals for the 6.68-ev resonance of $^{238}U$ in H–U and C–U mixtures are included, showing that the IR values are in closer agreement with the results of a numerical integration than are results obtained by application of narrow and wide resonance approximations to the moderator and absorber, respectively. The extension to nonhomogeneous systems is briefly considered. (D.C.W.)

**33209** ON TRANSFER CROSS SECTIONS BETWEEN OVERLAPPING THERMAL GROUPS. Hembd, H. (Joint Nuclear Research Center, Ispra, Italy). Nucl. Sci. Eng., 22: 389-91(July 1965).

In a system of moderators at different temperatures, neutrons that have been thermalized in one medium may diffuse into another medium where they may be rethermalized. The transfer (rethermalization) cross sections are calculated for the case of two purely scattering moderators at different temperatures. (D.C.W.)

**33210** DIFFUSION COEFFICIENT OF THERMAL NEUTRONS FOR A MAXWELLIAN GAS. Marsico, B.; Molinari, V. G.; Scozzafava, R. (EURATOM-CNEN, Frascati, Rome). Nucl. Sci. Eng., 22: 391-2(July 1965).

An analytical expression is obtained for the diffusion coefficient of thermal neutrons for a gas of free protons that are in motion with a Maxwellian distribution of velocities. From comparison of the values obtained by the free-proton gas model with values obtained by other models and experiments, it was concluded that the free-proton gas model overestimates the diffusion coefficient for water and hydrocarbons by a factor of 2 to 3. (D.C.W.)

**33211** AN APPROXIMATE SOLUTION OF THE TWO-OVERLAPPING-THERMAL-GROUP DIFFUSION EQUATIONS. Breen, R. J.; Yasinsky, J. B. (Westinghouse Electric Corp., West Mifflin, Penna.). Nucl. Sci. Eng., 22: 392-4(July 1965). (WAPD-T-1749)

An approximate solution of the diffusion equations with two overlapping thermal groups is outlined. (D.C.W.)

**33212** CALCULATION OF THE SCATTERING OF LOW-ENERGY NEUTRONS ON FREE MOLECULES. Zech, Hans-Juergen (Kernforschungszentrums, Karlsruhe, Ger.). Z. Naturforsch., 20a: 380-6(Mar. 1965). (In German)

The Volkin expansion of the Zemach and Glauber theory

for the scattering of low energy neutrons on free molecules is simplified and modified. Another treatment of an operator sum makes it possible to find a much better initial approximation which shows similarity with the Krieger-Nelkin approximation. Corrections to this initial approximation are given. The results of a calculation for water in the gaseous phase by the Volkin method and the present method are compared with the measured values made by Hofmeyer on steam. There is a better agreement between theory and experiment with the present method than with the Volkin method. (tr-auth)

**33213** INELASTIC SMALL ANGLE SCATTERING OF NEUTRONS IN FERROMAGNETICS. Maleev, S. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 1448-58(May 1965). (In Russian)

Small-angle inelastic scattering of slow neutrons in ferromagnetics is considered in the case when the change in neutron energy during scattering is comparable to the energy of magnetic interaction between atomic spins or between the spins and external magnetic field. It is found that scattering involving spin-wave absorption occurs in a broader range of angles than scattering involving spin-wave emission. In the angular range in which only scattering with absorption occurs, there should be, in some cases, a strong dependence of the cross section on neutron polarization; and if the incident neutrons are not polarized, scattering should lead to appreciable polarization. It is demonstrated, furthermore, that sufficiently slow neutrons in general cannot be scattered with concurrent emission or absorption of a single spin wave. Some recent experiments on small-angle scattering in ferromagnetics are discussed. (auth)

**33214** SLOW NEUTRONS. Turchin, V. F. Translated from Medlennye Neitrony. New York, Daniel Davey and Co., Inc., 1965. 310p. $16.50.

Theory is presented for the scattering of thermal neutrons in gases, liquids, and solids, including magnetic scattering. The principles of thermal-neutron spectrometry are outlined, with emphasis on the measurement of scattering amplitudes and cross sections. Neutron diffusion and thermalization are also treated in connection with the establishment of the spectrum and spatial distribution of thermal neutrons in various media. 158 references. (D.C.W.)

**33215** SPATIALLY DEPENDENT ASYMPTOTIC NEUTRON SPECTRAL MEASUREMENTS IN WATER AND POLYETHYLENE. Gaerttner, E. R.; Fullwood, R. R.; Menzel, J. H.; Toth, G. P.; Slovacek, R. E. (Rensselaer Polytechnic Inst., Troy, N. Y.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/55, 21p. (CONF-650504-23)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

An experimental technique for measuring spatially dependent asymptotic spectra is described, and measurements for polyethylene and water in slab geometry are summarized. The spatial distribution of the scalar flux amplitudes in water at several energies were determined, together with the spatial variations of the current, directional and scalar flux shapes in water from 0.005 to 0.20 ev. The extrapolation lengths for polyethylene and water were also obtained as functions of energy. (D.C.W.)

**33216** SPECTRAL CORRECTION ANALYSIS OF PULSED NEUTRON DIFFUSION PARAMETERS. De Juren, J. A. (Atomics International, Canoga Park, Calif.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/59, 14p. (CONF-650504-21)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The conventional expansion of the decay constant as a power series of the buckling in moderator die-away experiments is abandoned. Instead, the decay constant is expressed as $\alpha_B = v\Sigma_a + D_B B^2$, where $D_B = (\lambda_B v_B/3)$, and for $B^2 = 0$, $D_0 = (\lambda_0 v_0/3)$. The assumption is made that the cooling from neutron leakage in a finite moderator reduces the effective Maxwellian temperature of the neutron spectrum, $T_B$, from the moderator temperature $T_0$. To take into account the variation of transport mean free path, $\lambda_B$, and the velocity with buckling, the temperature dependence of the diffusion coefficient is assumed to be $D_B = D_0 (T_B/T_0)^w$, where w may be evaluated from diffusion length (or pulsed) measurements at different temperatures. These expressions may be related by means of the heat transfer coefficient, $\gamma$. The average heat transfer from the moderator to a neutron is $(dE/dt) = \frac{3}{2}k\gamma(T_0 - T_B)$. The following relations are derived: $(T_0/T_B) = 1 + (2w/3\gamma) D_B B^2$, or $(v_0/v_B) = [1 + (2w/3\gamma) D_B B^2]^{\frac{1}{2}}$, $D_0 = D_B[1 + (2w/3\gamma) D_B B^2]^w$. A code was developed to determine $v\Sigma_a$, $D_0$, $\gamma$, and $v_B/v_0$ from these relations. Results are given for graphite, beryllium, light water, and heavy water. (auth)

**33217** TIME AND SPACE EIGENVALUES OF THE BOLTZMANN EQUATION. Wood, J. (Univ. of Birmingham, Eng.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/44, 34p. (CONF-650504-25)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

Two problems in neutron thermalization have aroused considerable experimental and theoretical interest. The experiments are the pulsed source in a pure moderator and the measurement of diffusion length. Recently Corngold discussed the theory of the spectra of the eigenvalues (decay constants) arising from the consideration of these two problems. From the viewpoint of Corngold's theory, the temporal and spatial eigenvalues of a number of kernels are studied. Three methods of solving the Boltzmann transport equation are used; their accuracy is compared. The methods studied are the diffusion approximation, the $P_3$ approximation, and the $B_0$ approximation. The equations are solved numerically; and, in the case of the $B_0$ method, a new iterative scheme is applied to the resulting nonlinear eigenvalue problem which given good convergence. The kernels used include the gas model, the effective width model of Schofield and Egelstaff, and the crystal model (incoherent approximation). The effect on the scattering cross sections of varying parameters in these models is shown graphically. The effective width model is used to represent light water, and the dependence of thermalization parameters on the effective width parameter giving optimum agreement with experimental values of these thermalization parameters is obtained. Results are tabulated for the variation of the time-dependent eigenvalues with size of system ($B^2$) and the variation of the spatial eigenvalues with increased absorber concentration. The approach of the eigenvalues to a limiting value is shown graphically. The energy spectra of space and time-dependent transients in a pulsed slab are also shown. (auth)

**33218** SOME SPECTRAL PROPERTIES OF THE TRANSPORT EQUATION AND THEIR CONNECTION WITH THE THEORY OF PULSED NEUTRON EXPERIMENTS. Albertoni, S.; Montagnini, B. (Universita, Milan). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/17, 27p. (CONF-650504-34)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The eigenvalue spectrum of the transport equation is studied for the case of a finite homogeneous convex body of arbitrary shape, surrounded by vacuum. Results obtained previously under the assumption of isotropic scattering are summarized. The assumption of isotropic scattering is then suspended, and the exact free gas scattering kernel is used. It is found that the most significant previous results are still valid if the free gas scattering kernel is used. (D.C.W.)

**33219** TECHNIQUES CLOSELY RELATED TO PULSED NEUTRON RESEARCH. Uhrig, R. E. (Univ. of Florida, Gainesville). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/76, 73p. (CONF-650504-17)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

A variety of techniques related to the conventional pulsed neutron technique is described, including the sinusoidal-modulation technique, square-wave pulsing, and pseudo-random pulsing. The theoretical bases are outlined, and

experimental results obtained by different techniques are compared. Thermal neutron pulse propagation is also considered, together with some instrumentation and facilities. 60 references. (D.C.W.)

**33220** PULSED NEUTRON SOURCE AND REACTOR NOISE STUDIES OF PLUTONIUM SYSTEMS. Bierman, S. R.; Clayton, E. D. (Battelle Memorial Inst., Richland, Wash.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/60, 38p. (CONF-650504-20)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The results of pulsed neutron source experiments and reactor noise measurements performed on small plutonium systems are presented, and comparisons between the two methods of measurement are given. The measurements were made during approach-to-critical experiments performed in the Critical Mass Laboratory at Hanford and cover both thermal and intermediate systems of ideal geometry. The primary parameter experimentally determined in each measurement was the prompt neutron decay constant, $\alpha$. For all the critical plutonium assemblies studied, excellent agreement was obtained between the pulsed neutron source and reactor noise determinations of the prompt neutron decay constant. (auth)

**33221** THE PULSED NEUTRON TECHNIQUE APPLIED TO FAST NON-MULTIPLYING ASSEMBLIES. Beghian, L. E.; Wilensky, S. (Massachusetts Inst. of Tech., Cambridge). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/74, 26p. (CONF-650504-18).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

A nanosecond pulsed Van de Graaff accelerator was used to study the behavior of fast neutrons in non-multiplying metal assemblies. A pulsed neutron source technique was used to measure fast non-elastic cross sections for iron. The method used is similar to that used to measure absorption cross sections in thermal assemblies, with the exception that the fast decay times are the order of nanoseconds rather than microseconds. Nanosecond bursts of monoenergetic neutrons are injected into various size iron assemblies. The neutron flux in these assemblies is observed to decay exponentially with a characteristic decay constant. The decay constant is composed of a sum of terms which represent neutron loss due to leakage and energy degradation. Energy degradation represents a neutron loss since a biased neutron detector is used. The removal term due to elastic and nonelastic scattering can be determined by measuring the decay constant as a function of assembly size. A theoretical development is presented for calculating the fraction that the elastic scattering contributes to the removal term, hence the nonelastic cross section can be determined. The theoretical treatment for calculating the elastic contribution was varified experimentally. The nonelastic cross section for iron was measured by this technique for primary neutron energies between 0.8 and 1.5 Mev. The pulsed source technique described was used to measure decay constants for lead slabs. The experiment approximates the assumptions which are generally made when solving the time-dependent Boltzmann transport equation. Decay constants were measured for 28 in. × 32 in. lead slabs of 2-, 4-, 5-, and 8-in. thickness. The results, after correction for energy degradation and finite assembly, are compared with the approximate solutions of the Boltzmann transport equation. (auth)

**33222** HIGH OUTPUT NEUTRON GENERATING TUBES FOR REACTIVITY MEASUREMENTS. Lomer, P. D. (Services Electronics Research Lab., Baldock, Herts, Eng.); Bounden, J. E.; Wood, J. D. L. H.; Barnes, W. J. Vienna, International Atomic Energy Agency, 1965, Paper SM-62/28, 18p. (CONF-650504-30)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

A neutron source with a tubular configuration is described from which a continuous yield of $10^{10}$ neutrons/sec can be obtained. The neutron output can be modulated over a range of pulse lengths from 30 sec to 100 $\mu$sec. (D.C.W.)

**33223** NEUTRON THERMALIZATION PARAMETERS. Purchit, S. N. (Aktiebolaget Atomenergi, Studsvik, Sweden); Sjoestrand, N. G. Vienna, International Atomic Energy Agency, 1965, Paper SM-62/32, 16p. (CONF-650504-27)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

A critical discussion of the neutron thermalization parameters employed to describe the transient time and space-dependent phenomena is presented. These parameters are $M_2$, the second energy transfer moment of the scattering kernel weighted by the Maxwellian distribution; the thermalization time constant, the diffusion cooling coefficient; the thermal diffusion length; the rethermalization length; the diffusion heating coefficient; and the limit of the decay constant ($v\Sigma_a$) min. The determination of the time and space transient parameters using the polynomial representation for the energy part of the neutron flux is discussed. Based upon the low-order polynomial expansion, interrelations between various parameters are obtained. Limitations of these expressions in the analysis of transient phenomena are pointed out. An attempt is made to compare theoretical and experimental results for several moderators. Theoretical $M_2$ values are obtained using the first term of the Placzek mass expansion and the correction with the generalized Doppler approximation. In these calculations available theoretical or derived frequency spectra of the dynamical modes of the moderators are used. Various experimental methods for the determination of neutron thermalization parameters are compared. The uncertainties and limitations of the different methods are pointed out. Available experimental data are surveyed, and a list of "best values" is suggested. The comparison between theoretical and experimental data shows that a large theoretical and experimental effort is needed to obtain a full understanding of the results. 52 references. (auth)

**33224** THE DIFFUSION PARAMETERS OF HEAVY WATER. Daughtry, J. W.; Waltner, A. W. (North Carolina State Univ., Raleigh). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/62, 26p. (CONF-650504-19).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The diffusion parameters of heavy water were measured at North Carolina State University over a temperature range of 25 to 250°C by means of the pulsed source method. A 1-Mev HVEC van de Graaff, pulsed at the ion source, was used to generate the neutron pulses by means of the $Be^9(d,n)$ reaction. Neutrons were injected into cylindrical volumes of $D_2O$, and the decay constants of the neutrons were determined by means of a $BF_3$ counter located under the $D_2O$ container and oriented along its diameter, operating into a 26-channel time analyzer. The time required to establish the asymptotic spectrum in $D_2O$ was first measured by means of a transmission experiment involving a boron absorber and a Li I (Eu) scintillator. It was observed that a time of 200 microseconds was sufficient to establish the asymptotic spectrum. The approach to the asymptotic spectrum can be approximated by a time constant of 36 microseconds. The diffusion parameters, $D_0$ and C, were determined by fitting the measured decay constants to the equation $\lambda = \lambda_0 + D_0B^2 - CB^4$. The infinite medium decay constant was calculated from known density and cross section data. An iterative process was used to make the value of the extrapolation distance compatible with the diffusion coefficient $D_0$. The values of $D_0$ obtained were somewhat lower than those of Baumann, who measured D by a static method using a copper poisoning technique. These values were converted to $D_0$ by multiplying D by the average temperature of the moderator. The theoretical values of Honeck and Michael, obtained by direct solution of the transport equation, fall between the results of Baumann and those of this experiment. (auth)

**33225** SPECTRUM OF THE BOLTZMANN OPERATOR WITH AN ISOTROPIC THERMALIZATION KERNEL. Bednarz, R. (Inst. of Nuclear Research, Swierk, Poland).

Vienna, International Atomic Energy Agency, 1965, Paper SM-62101, 17p. (CONF-650504-16).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The spectrum of the transport operator with an isotropic thermalization kernel was studied in the Hilbert space of the square integrable functions over the six-dimensional set. The set is a Cartesian product of the unbounded velocity space and a convex bounded body. The operator has a domain with functions permitting the directional derivative and vanishing at the boundary for velocity directions entering the body. The kernel was symmetrized according to the detailed balance condition and was assumed to be square integrable. The total collision rate must reach its minimum value (bound of the point spectrum) at zero velocity and must behave like a linear function for large velocities. With an additional assumption that the total collision rate has a positive derivative on the set of positive measure including zero velocity, the spectral theorem is proved. The spectral plane is divided into two half planes by the straight line perpendicular to the real axis. This line crosses the negative real axis at the bound of the point spectrum. The left half plane including this line is all contained in the spectrum. The right open half plane belongs to the resolvent set part of the real axis on which the point spectrum may be situated. It is found that the point spectrum exists for sufficiently large samples, but vanishes for sufficiently small samples. The first result is equivalent to the absence of a normal mode and was obtained by Nelkin for a separable thermalization kernel and by Albertoni and Montagnini for the free gas kernel. Finally, the applicability of the spectral theorem to the interpretation of pulsed neutron experiments with solids and liquids is discussed. (auth)

**33226** NEUTRON MODERATION STUDIED BY THE TIME-DEPENDENT REACTION RATE METHOD. Moeller, E. (Aktiebolaget Atomenergi, Studsvik, Sweden). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/30, 15p. (CONF-650504-29).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

Time-dependent neutron spectra have been studied in water, ice and heavy water, using the 5.5-Mv Van de Graaff accelerator at Studsvik as a pulsed neutron source. The change with time of the spectrum after the injection of the neutrons in the moderator was followed by the detection and time analysis of prompt gamma rays from the reaction between the flux and neutron capturing spectrum indicators with known capture cross sections, which were distributed in small quantities in the moderator. Earlier measurements on the thermalization in water were extended to the slowing-down region by the use of indium as spectrum indicator and measuring with a time resolution of 0.05 $\mu$s. The results are in good agreement with the theory for the slowing down by collisions against free protons. The space-dependence near the source of the time-dependent neutron density was compared with recent theoretical work. In ice the thermalization time constant was measured. The value obtained, 5 $\mu$s, deviates only slightly from the value earlier obtained for water after correction for the density difference. This implies only a small difference in the integral parameters of the scattering law for the two states of water. Time-dependent reaction rate curves were also measured for heavy water, using a volume of 50 l and cadmium as an indicator. Since leakage effects complicate the interpretation of the results, the measurements were extended to larger geometries in order to permit comparison with infinite medium calculations. Preliminary results are given. (auth)

**33227** TIME-DEPENDENT NEUTRON THERMALIZATION IN LIQUID MODERATORS $H_2O$ AND $D_2O$. Purchit, S. N. (Aktiebolaget Atomenergi, Studsvik, Sweden). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/31, 18p. (CONF-650504-28).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

Theoretical studies of time-dependent thermal-neutron spectra for the scattering models of $H_2O$ and $D_2O$ were undertaken. Using the Boltzmann transport equation, these spectra were numerically generated with a multi-group program, NEFLUDI TDCS. From the calculated spectra, reaction rates for Cd, Sm and Gd, the resonance detectors, were obtained. In the case of light water studies, the free proton gas and the bound proton model of Nelkin were used as the scattering models. The source for thermal neutrons at $10^{-2}$ $\mu$sec, for these cases, was obtained by the Ornstein-Uhlenbeck solution for the slowing down of a pulse of neutrons in hydrogen. Theoretical reaction rates obtained in these studies are compared with the results of the experiments of Möller and Sjöstrand. The proton gas model is found to be inadequate to explain the measured reaction rates. The oscillator model of Nelkin, for the bound protons in $H_2O$, improves the agreement between theory and experiment. However, some disagreement still persists. The effect of variation of the relative weight between the intramolecular vibrations and hindered rotations on the reaction rates has also been studied. Theoretical reaction rates were also determined for the neutron scattering model of Butler for $D_2O$. The von Dardel expression for the time-dependent neutron flux, in an infinite medium of deuterons, was used to compute the source for the thermal neutrons in this study. A comparison of the theoretical reaction rates for $H_2O$ and $D_2O$ is also given. The improvement of the Nelkin model with regard to the relative weight between the dynamical modes and the structure of hindered rotations is considered. The effect of the replacement of the delta function representation, for the hindered rotations in $H_2O$ and $D_2O$, with the structure on the integral parameters was discussed. The analysis of the integral experiments to obtain a parameter of the neutron scattering law for a moderator is proposed. (auth)

**33228** THE EFFECT OF NON-UNIFORM MODERATOR TEMPERATURE ON THE EPITHERMAL NEUTRON SPECTRUM. Williams, M. M. R. (Univ. of Birmingham, Eng.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/45, 19p. (CONF-650504-24).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The neutron spectrum from a high-energy source in an infinite 1/v absorbing medium, possessing a non-uniform temperature variation, is obtained for an arbitrary scattering kernel. The diffusion approximation is used to represent the spatial variation of flux, and methods are discussed whereby the full Boltzmann equation can also be used. The resulting energy spectrum is in the form of an asymptotic series in inverse powers of neutron velocity. The first and second terms in the series are spatially constant and represent the well known 1/E slowing down flux with a correction for absorption. Succeeding terms depend upon the spatial variation of the physical temperature and contain quantities which are functions of the chemical binding and absorption of the moderator. For constant temperature, the solution becomes identical to that derived some years ago by Corngold for infinite homogeneous media. Numerical results are presented for various moderators and physical temperature variations. (auth)

**33229** DIFFUSION PARAMETERS OF BeO BY PULSED NEUTRON METHOD. Joshi, B. V.; Nargundkar, V. R.; Subbarao, K. (Atomic Energy Establishment, Trombay, India). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/39, 24p. (CONF-650504-26).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The use of the pulsed neutron method for the precise determination of the diffusion parameters of moderators is described. The diffusion parameters of BeO were obtained by this method. The neutron bursts were produced from a cascade accelerator by pulsing the ion source and using the Be(d,n) reaction. The detector was an enriched boron trifluoride proportional counter. It is shown that by a proper choice of the counter position and length, and the source position, most of the space harmonics can be eliminated. Any constant background can be accounted for in the calculation of the decay constant. Very large bucklings

were not used to avoid time harmonics. Any remaining harmonic content was rendered ineffective by the use of adequate time delay. The decay constant of the fundamental mode of the thermal neutron population was determined for several bucklings. Conditions to be satisfied for an accurate determination of the diffusion cooling constant, C, are discussed. The effect of neglecting the contribution of the $B^6$ term on the determination of the diffusion parameters was estimated and is shown to be considerable. The reason for the longstanding discrepancy between the values of C obtained for the same moderator by different workers is attributed to this. (auth)

**33230** THE THEORY OF PULSED NEUTRON EXPERIMENTS IN HETEROGENEOUS MULTIPLYING MEDIA. Corno, S. E. (Universita, Pavia, Italy). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/8, 25p. (CONF-650504-35)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The time and space dependences of the neutron flux within a highly heterogeneous assembly are investigated, in which pulsed or sinusoidally modulated neutrons are injected. A device consisting of a cylindrical block of heavy moderator is considered, along the axis of which a line-shaped region of fissionable material is located. The forcing neutron source is assumed to be located on one of the end faces of the cylinder. The extent of the fissionable region allows us to deal with it as with an absorbing and multiplying singularity of the neutron field. As attention is mostly concentrated on the space and time variations of the neutron flux, rather crude approximations are assumed as far as the energy dependence of the neutron population is concerned. Within the limits of the age-diffusion theory, the response of the device to any neutron excitation may be found in closed form. For a sinusoidally modulated source of given frequency, it may easily be shown that, if the axial singularity were a purely absorbing one, the neutron waves being propagated along the device would possess a phase, a wave-length, and an attenuation constant depending on the absorbing properties of the singularity. This picture becomes more and more complicated when neutron multiplication occurs. For this general case, the solution derived turns out to be dependent on both absorption and multiplication properties of the singularity. This circumstance suggests, among others, the idea of using a device of the type described above for testing fuel elements of heterogeneous reactors. (auth)

**33231** THERMALIZATION STUDIES OF ORDINARY AND HEAVY WATER. Sinclair, R. N.; Williams, P. J. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/22, 22p. (CONF-650504-33).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

Thermal neutron spectra in ordinary and heavy water were studied by the time-of-flight technique using the 45-Mev Linac at Harwell. The experiments are designed to investigate the sensitivity of the spectra to the details of the scattering kernel in regions of isotropic flux and near boundaries where the anisotropy is high. Spectra in a large volume of heavy water poisoned with a 1/v absorber (boron) or a resonant absorber (cadmium) were measured at 293 and 360°K. The results are compared with spectra calculated in the infinite medium approximation with the SIMPH code. A leakage correction is determined from the spatial flux variation as measured by gold and manganese activations. The scattering kernels used in the calculations are based on different models of the dynamics of the heavy water molecule. Earlier measurements of the spectra incident on a totally absorbing surface immersed in ordinary water were extended to include neutrons moving at glancing angles to the surface. The experiments demonstrate the effects of the finite moderator size and the source position on the leakage spectra; these effects are confined to energies greater than about 0.1 ev. Below this energy, the combined results show that there is little change in the spectra as a function of angle $\mu$ greater than 0.2 ($\mu$ is the cosine of the angle between the neutron direction and the normal to the surface). For $\mu = 0$ the spectrum is very close to a Maxwellian distribution with $T_n = 1.05\ T_m$, where $T_n$ and $T_m$ are the neutron and moderator temperatures. The spectra are compared with calculations made with the Winfrith DSN code on the assumption that the scattering is isotropic. (auth)

**33232** MEASUREMENTS OF FAST NEUTRON SPECTRA IN REACTOR MATERIALS. Gayther, D. B.; Goode, P. D. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/23, 12p. (CONF-650504-32).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

In order to test theoretical methods of calculating neutron spectra in fast reactors, a series of measurements of spectra in simple assemblies of pure materials was made. The Harwell 45-Mev electron linear accelerator produced a pulse of fast neutrons in a natural uranium target which was placed at the center or on the side of the assembly, and the spectrum of neutrons emerging from its surface or from a central re-entrant hole was measured by the time-of-flight technique. A flight path length of 60 m was used, and the maximum time resolution was 1 nanosec/m. The spectrum measurements covered the energy range from 1 kev to 5 Mev using three types of neutron detector. For energies from 5 kev to 1 Mev, a boron plug detector was used, which consisted of a thin walled aluminum container packed with $^{10}B$ metal, the gamma rays from the $^{10}B(n,\alpha\gamma)$ reaction being detected in four NaI crystals mounted on photomultipliers. Measurements in the range 0.5 to 5 Mev were made with a plastic scintillator and the low-energy region was covered with a $^6Li$ glass scintillator. In order to obtain an energy spectrum from the observed time-of-flight data, allowance had to be made for the energy dependence of the efficiencies of the detectors. These were determined by direct comparison with a calibrated long counter using the Harwell 3-Mev pulsed Van de Graaff as a monoenergetic source of neutrons. The experimental method is described, and a comparison is given between measured and theoretical spectra. (auth)

**33233** NEUTRON SOURCE. Cherubini, Julian H. (to High Voltage Engineering Corp.). U. S. Patent 3,183,356. May 11, 1965. Filed July 30, 1962.

Preparation of a high energy, high yield lithium tritide target for neutron sources is described. The target is prepared in an atmosphere of tritium gas at a pressure of approximately 7 psig by introducing melted lithium into the tritium atmosphere to produce lithium tritide that is ground to a powder of less than 170 mesh. The powdered lithium tritide (20–80 vol %) is mixed with Al powder (80–20 vol %) of the same mesh size, and the mixture is compacted into a foil by a cold pressing or modified evacuated pack rolling technique to a thickness of one or two mils to a density exceeding 98% of theoretical. Coupons of the desired size are punched out of the foil and are vapor coated with a metal such as Cu or Al. The coated coupon is soldered onto a backing disc of Cu or some other high conductivity metal. (B.L.M.)

## Nuclear Properties and Reactions

*Refer also to abstracts 32284, 32547, 32671, 32680, 32956, and 33049.*

**33234** (AAEC/TM-270) SOME CALCULATED INFINITELY DILUTE RESONANCE INTEGRALS. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1964. 14p. Dep. (mn).

A program was written for the IBM 1620 computer to calculate infinitely dilute resonance integrals over any energy range. The contribution of higher l states is included in the estimate for the integral above the last resolved resonance. A spectrum $E^{\delta-1}$ may be used in the calculation to simulate an epithermal spectrum in an inte-

gral measurement. The theory of the calculation is outlined, and results are given for some heavy nuclides. A number of calculations were performed for $^{232}$Th where there is some disagreement between experimental results and theoretical estimates. (auth)

**33235** (AERE-R-4263) LOW-ENERGY NEUTRON INELASTIC SCATTERING EXPERIMENTS WITH A LINEAR ACCELERATOR. Webb, F. J. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1965. 47p. Dep.; $1.40(BIS), 7s.(HMSO).

Most low-energy neutron inelastic scattering measurements were made using reactors as neutron sources. Such experiments are satisfactory in the thermal neutron region, but the falling neutron intensity above 0.2 ev limits the range of measurement. Linear accelerators are able to provide high neutron fluxes and to extend inelastic scattering measurements to 1 ev or higher. Four methods are considered, employing a linear accelerator as neutron source in combination with a crystal analyzer, a filter analyzer, a crystal monochromator, and a mechanical monochromator. Of these methods the last yields the highest resolution and allows speedy collection of data. The crystal analyzer method is simpler, but is slower in collecting data. The filter analyzer method is a simple experiment, but the data which can be obtained are limited. (auth)

**33236** (AERE-R-4896) ABSOLUTE POLARIZATION MEASUREMENTS IN PROTON SCATTERING IN THE 140-Mev ENERGY RANGE. Jarvis, O. N.; Rose, B.; Scanlon, J. P. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1965. 38p. Dep.; $1.10(BIS), 5s. 6d. (HMSO).

The polarization of the proton beam extracted from the 110-in. Synchrocyclotron was determined to an accuracy of ±1% using two independent techniques. Measurements with this beam showed that the absolute calibration of all the published proton-nucleus polarization data in the energy range between 50 and 150 Mev are considerably in error. This fact means that the proton-proton polarization data are also in error. The appropriate correction factors to be applied to the published experimental results are listed. (auth)

**33237** (ANL-7020(p.226-30)) DETERMINATION OF NUCLEAR CONSTANTS. (Argonne National Lab., Ill.).

The fast neutron cross section program and the kind of data needed for the calculation of breeding ratios of fast reactors are described. Experimental cross sections are given for the excitation of the 0.741-, 0.809-, and 0.958-Mev states of $^{93}$Nb by neutron inelastic scattering and for radiative capture (n,γ) in $^{185}$Re and $^{187}$Re. Measurements of capture-to-fission ratios in EBR-II are underway for several U and Pu isotopes. (D.L.C.)

**33238** (CONF-650524-1) NEUTRON SCATTERING FROM NON-SPHERICAL NUCLEI. Dunford, C.; Reynolds, J. T. (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 1965. Contract W-31-109-eng-52. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From European Nuclear Energy Agency and Atomic Energy Commission Seminar, Upton, N. Y.

A program (2PLUS) is written that calculates differential cross sections for neutrons scattered elastically and inelastically from nuclei having $0^+$ ground states, to the lowest $2^+$ states of these nuclei. The program uses a non-spherical optical model. The fit between the calculated and experimental values of the cross sections for 0.56-Mev neutrons on $^{232}$Th is shown as an example. (T.F.H.)

**33239** (HW-SA-3588) SUBSTRUCTURE IN THE NEUTRON TOTAL CROSS SECTION IN THE REGION OF THE GIANT RESONANCES. Foster, D. G., Jr.; Glasgow, D. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). [June 25, 1964]. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Substructure in the giant resonances of the neutron total cross sections at 2 to 15 Mev is observed, for nuclei and elements having atomic weights of 20 to 210. The measurements are carried out with resolution of 2 to 4% and precision of 1 to 3%. The excitation functions of individual elements exhibit fluctuations, and when the fluctuations are smoothed out, the three-dimensional plot of cross section as function of energy and atomic weight exhibits substantial local departures from optical-model behavior. (T.F.H.)

**33240** (IFA-CRD-30) ANGULAR DISTRIBUTION OF NEUTRONS FROM THE $Mn^{55}(\alpha,n)Co^{58}$ REACTION AT $E_\alpha$ = 14 AND 17 Mev. Alevra, A.; Dumitrescu, R.; Lukas, I. R.; Magda, M. T.; Martalogu, N.; Plostinaru, D.; Poenaru, D.; Trutia, E.; Vilcov, I.; Vilcov, N. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest). Apr. 1965. 16p. Dep.(mn).

The angular distribution of neutrons from the $^{55}$Mn(α,n) $^{58}$Co reaction was measured at bombarding energies $E_\alpha$ = 14 and 17 Mev and for various intervals of the excitation energy, E*, in the residual nucleus $^{58}$Co. The angular distribution in the range E = 1 to 4 Mev shows a forward peak, indicating a direct interaction contribution to the reaction. The angular distributions in the ranges E* = 4 to 5, 5 to 6, and 6 to 7 Mev were treated in the frame-work of the compound nucleus statistical theory and were used to calculate the ratio of $^{58}$Co moment of inertia to moment of inertia of a rigid spherical nucleus. The data are completed by the angular distribution of the apparent temperature of the $^{58}$Co nucleus. (auth)

**33241** (INR-461/I) ISOMERIC CROSS SECTION RATIOS FOR SOME REACTIONS INDUCED BY NEUTRONS IN TIN AND TELLURIUM ISOTOPES. Brzosko, J.; Decowski, P.; Siwek-Diament, K.; Wilhelmi, Z. (Institute of Nuclear Research, Warsaw (Poland)). July 1963. 42p. Dep.

The cross sections of several 14.9-Mev neutron induced reactions forming the following isomeric pairs were measured: $^{118}$Sn(n,p)$^{118g}$In, 0.4 ± 0.2 mb; $^{118}$Sn(n,p)$^{118m}$In, 5.8 ± 0.2 mb; $^{119}$Sn(n,p)$^{119g}$In, 4.3 ± 1.5 mb; $^{119}$Sn(n,p)$^{119m}$In, 4.3 ± 1.4 mb; $^{118}$Sn(n,np)$^{117g}$In, 0.93 ± 0.26 mb; $^{118}$Sn(n,np)$^{117m}$In, 0.49 ± 0.14 mb; $^{118}$Sn(n,2n)$^{117m}$Sn, 1230 ± 340 mb; $^{130}$Te (n,2n)$^{129g}$Te, 210 ± 46 mb; and $^{130}$Te(n,2n)$^{129m}$Te, 247 ± 74 mb. The results were compared with predictions of the statistical theory. In conjunction with previous work concerning the development of (n,p) reactions for other tin and tellurium isotopes, the present work enabled Levkovskij's effect to be tested. The experimental isomeric ratios were correlated with results given by the statistical model of the compound nucleus. This comparison indicates a pronounced participation of the direct mechanism in (n,p) reactions. (auth)

**33242** (ISS-64/45) A SEARCH FOR TETRANEUTRONS PHOTOPRODUCED IN LIQUID HELIUM. Amaldi, U., Jr.; Fronterotta, G.; Matthiae, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Nov. 30, 1964. 11p. Dep.(mn).

At the Frascati Electron Synchrotron, a search was made of tetraneutrons photoproduced through the reaction $\gamma + {}^4He \rightarrow 2\pi^+ + {}^4n$. Tetraneutrons are revealed by means of the reaction $^{27}$Al($^4$n,2n)$^{29}$Al. An aluminum block surrounds the liquid helium target and the production of $^{29}$Al should show up through the successive emission of 2.43-Mev γ rays. Since a γ activity of this energy was not revealed, an upper limit is put on the average production cross section: $\bar{\sigma} = (-1.7 \pm 1.7)\mu b$. (auth)

**33243** (JAERI-4032) SURVEY OF NEUTRON CROSS SECTIONS REPORTED FOR Z ≥ 93. Igarasi, Sin-iti; Yamamoto, Masaaki (Japan Atomic Energy Research Inst., Tokyo). 1965. 35p. Dep.(mn). (In Japanese and English).

A survey of the experimental data of neutron cross sections, resonance parameters, etc. for Np, Pu, Am, Cf, Fm, Es, and Cm is presented. Experimental method, energy range, accuracy of data, and remarks are briefly described for each individual reference. The data are also listed in a tabular form, classified by nuclide. 119 references. (auth)

**33244** (JINR-P-2079) PROBLEMA DEITRONNYKH POROGOVYKH SOSTOYANII V LEGKIKH YADRAKH. (On

Deuteron Threshold States in Light Nuclei). Balashov, V. V.; Rotter, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 7p. Dep. (mn).

The microstructure of deuteron states excited in the reactions ($^6$Li, $\alpha$) by a direct deuteron transfer to the target nucleus is considered. A calculation was made of the spectra of the deuteron reduced widths in the channels $^6$Li + d → $^8$Be and $^9$Be + d → $^{11}$B. The main maximum of the spectra has a shape of the giant resonance and lies, according to experiment, in a region close to the threshold of the deuteron disintegration of the finite nucleus. It is explained at the same time, why in the reaction $^6$Li($^6$Li, $\alpha$) $^8$Be there is a branch which corresponds to the ground and the first excited states of $^8$Be. (auth)

**33245** (JINR-P-2086) "KOLLEKTIVNYE" UROVNI V DEFORMIROVANNYKH YADRAKH S NECHETNYM A V OBLASTI REDKOZEMEL'NYKH ELEMENTOV. ("Collective" Levels in Deformed Nuclei With Odd A in the Rare-Earth Region). Gnatovich, V.; Gromov, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 12p. Dep.(mn).

A review is given of the experimental data on the collective levels in the deformed nuclei with odd A in the rare-earth region. (auth)

**33246** (KAPL-M-6455) CALCULATION OF THE BUILDUP OF CADMIUM DUE TO THE NEUTRON IRRADIATION OF SILVER. Bollacasa, Dario; Goldman, D. T. (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 15, 1965. Contract W-31-109-eng-52. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The buildup of cadmium isotopes following the irradiation of elemental silver is calculated for several values of thermal neutron flux. Two digital computer programs are used, one to calculate the flux weighted capture probability and the other to perform the depletion and buildup analysis. Sufficient detail is presented to enable the reader to modify the input quantities to suit a particular reactor configuration. (auth)

**33247** (NP-15048) O MEKHANIZME ($\pi^-$,$\pi^-$n) REAKTSII. (Mechanism of the $\pi^-$,$\pi^-$n Reaction). Report No. 27. Kolybasov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1964. 21p. Dep.(mn).

Total cross sections of the reaction $^{12}$C($\pi^-$,$\pi^-$n)$^{11}$C in the bombarding energy range from 40 to 600 Mev in the pole approximation were calculated. The calculated excitation function is in agreement with experimental data. The reduced vertex part (neutron width) of the virtual decay $^{12}$C → $^{11}$C + n was found from the absolute values of the cross sections. Its value turns out to be equal to that obtained from the pick-up reaction $^{12}$C(p,d)$^{11}$C. These facts confirm the hypothesis of the pole mechanism for the given reaction. (auth)

**33248** (SGAE-PH-17/1965) THE SPECTRUM OF THE MAIN BETA TRANSITION OF Au$^{198}$ AND THE K CONVERSION COEFFICIENT OF THE 412-kev GAMMA TRANSITION. Paul, Helmut (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). [1965]. 21p. Dep.(mn).

The shape factor of the 961-kev beta transition was measured and found to be 1-(0.031 ± 0.006)W, using a Siegbahn-Slätis intermediate-image spectrometer. This result is based on the Fermi-function by Dzhelepov and Zyrianova. The end-point energy is 961.0 ± 1.2 kev. By comparing the area under the K conversion line of the 412-kev transition in $^{198}$Hg to that under the continuous spectrum, the K conversion coefficient was determined to be (299 ± 2) × $10^{-4}$, in very good agreement with the theoretical value for an E2 transition. (auth)

**33249** (TID-21715) STUDIES OF LOW-ENERGY NUCLEAR REACTIONS—DECAY SCHEMES STUDIES. Final Report, February 15, 1964–February 14, 1965. Pate, Brian D. (Washington Univ., St. Louis. Dept. of Chemistry). Jan. 31, 1965. Contract AT(11-1)-870. 9p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

The $^{103}$Rh($\alpha$,n) and $^{103}$Rh($\alpha$,2n) excitation functions at 13 to 38 Mev alpha-particle energy are measured and shown. (T.F.H.)

**33250** (TID-21869) PARTICLE-HOLE SCATTERING SYSTEMS. Technical Report No. 78. Caine, C. A.; Lemmer, R. H. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Nov. 1964. Contract AT(30-1)-2098. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A theoretical investigation is presented of the scattering of a low-energy nucleon by a nucleus which, in the simple shell model, is represented by a single hole. As an example, the mass-16 system is considered. (T.F.H.)

**33251** (UCRL-11781) ELASTIC SCATTERING OF STRONGLY ABSORBED IONS (thesis). Hadjimichael, Evangelos (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 8, 1965. Contract W-7405-eng-48. 107p. Dep.(mn); $4.00(cy), 12(mn) CFSTI.

The interaction radius R and the nuclear surface thickness $\Delta$R of several nuclei have been investigated by phase-shift analysis of elastically scattered strongly absorbed ions. For the analysis, a diffraction model, modified to account for physical arguments that suggest a particular functional form for the nuclear phase shift and the partial-wave scattering amplitude as functions of the angular momentum, is used. The elastic scattering of $^{12}$C and $^{16}$O ions has been measured as a function of angle by using the Berkeley heavy-ion linear accelerator (Hilac). In addition, data were analyzed on elastic scattering of $\alpha$ particles, $^3$He ions, and deuterons at several energies. Unambiguous parameters were obtained from which the nuclear radius $R_n \approx r_a A^{\frac{1}{3}}$ and the nuclear surface thickness $\Delta$R were calculated. It was found that $\Delta R \approx 1.6 \times 10^{-13}$ cm and the radius parameter $r_a \approx 1.398 \times 10^{-13}$ cm. The total reaction cross sections were also calculated. A comparison with results obtained by other methods is presented. Finally, the versatility and validity of the model in the region of relativistic energies is demonstrated by its successful application to the $\pi^-$p elastic scattering at 2.01 Bev. (auth)

**33252** (ORNL-tr-627) CONCERNING THE EXCITATION OF ARTIFICIAL RADIOACTIVITY IN VARIOUS ELEMENTS. Meitner, Lise. Translated by J. J. Pinajian (Oak Ridge National Lab., Tenn.), from Naturwissenschaften, 22: 420(1934). 3p. Dep.(mn); $1.10(fs), $0.80 (mf) JCL.

The following reactions were observed in a Wilson cloud chamber: $^6$Li($\alpha$,n)$^9$B → $^9$Be + $e^+$, $^7$Li($\alpha$,p)$^{10}$Be → $^{10}$B + $e^-$, $^{19}$F($\alpha$,n)$^{22}$Na → $^{22}$Ne + $e^+$, and Zn($\alpha$,n)Ge → Ga + $e^+$. Lifetimes were measured for artificial radioactivities of Al, Si, and P. (D.L.C.)

**33253** ON THE FOUR-PARTICLE CORRELATION PROBLEM IN THE SUPERFLUID NUCLEAR MODEL. Pawlikowski, A.; Rybarska, W. (Wroclaw Univ., Poland). Acta Phys. Polon., 27: 537-44(Apr. 1965).

The problem of the existence of four-particle correlation in a superfluid-type nuclear model is examined. It is shown that approximate methods based on a linear transformation eliminate quadrupling of nucleons. The exact ground-state energy values are found (in the strong-coupling limit), and the existence of four-particle correlation in this model becomes obvious. (auth)

**33254** INTERSECTION OF ENERGETIC SURFACES OF LEVELS AND STRONGLY HINDERED ALPHA DECAY. Rykhanov, S. G. Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 21-5(1964). (In Russian)

The selection rules of gamma emission in the case where the level energy surfaces intersect were considered. The mean lifetimes of the isomeric state of some nuclei of the transuranium elements were evaluated. It is shown that the calculated lifetimes agree with the periods of alpha decay of such nuclei. (tr-auth)

**33255** STUDIES OF THE NATURAL ACTINIUM RADIOACTIVE SERIES. Nurmia, Matti (Oklahoma State Univ., Stillwater); Giessing, Daniel; Sievers, Wayne; Varga,

Louis. Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 167, 1-11 (1965).

$^{227}$Ac and its descendants were studied with gridded ionization chambers using fast radiochemical separations. The alpha branching ratio of $^{227}$Ac was 1.45 ± 0.06%. The half life of $^{215}$Bi was 7.4 ± 0.6 min. The beta branching of $^{211}$Bi was 0.27 ± 0.01%. The half life of $^{211}$Pb was 36.1 ± 0.2 min, and the half life of $^{211}$Bi was 2.13 ± 0.02 min. (auth)

**33256** CALCULATION OF INELASTIC SCATTERING IN TERMS OF ELASTIC SCATTERING. Austern, N. (Universitet, Copenhagen and Univ. of Pittsburgh); Blair, J. S. Ann. Phys. (N. Y.), 33: 15-64(June 2, 1965).

It is shown that the adiabatic distorted-wave theory of inelastic scattering, under suitable approximations, can be re-expressed in terms of derivatives of elastic scattering amplitudes. The methods are very general, and have the interesting aspect that they display relations which are directly among scattering amplitudes, so that the role of the optical potential is minimized. Results are obtained for all orders of the inelastic coupling constant, hence for single excitation (normal inelastic scattering), for double excitation, and for the reaction of inelastic coupling on the elastic scattering. The theory easily takes the form of a generalized diffraction model, and yields information about the reliability of such models. The older, Fraunhofer model of Blair is obtained as a special case. Two basic approximations are employed. Both are at their best if the projectile is absorbed strongly by the target nucleus, and if angular momentum transfers are much smaller than the angular momenta that are important for partial wave expansions. Approximation A simplifies the Green's functions that enter in calculations of the higher-order processes, so that the mathematical structure of such calculations becomes equivalent to that of first-order processes. Approximation B replaces the radial integrals which appear in first-order calculations by others which are known from the study of elastic scattering, and which are easily related to derivatives of the amplitudes for elastic scattering. (auth)

**33257** NUCLEAR ALIGNMENT OF $Co^{60}$ IN CERIUM MAGNESIUM NITRATE. Carboni, Fernando; Sapp, Richard C. (Univ. of Kansas, Lawrence). Ann. Phys. (N. Y.), 33: 77-87(June 2, 1965).

For a spherical single crystal of Ce−Mg nitrate containing $^{60}$Co cooled by adiabatic demagnetization from 24 kOe/°K, the gamma ray anisotropy $\epsilon$ is quite low (7%) compared to that for isomorphous Ce−Zn nitrate under comparable conditions (26%). In order to understand this apparently paradoxical behavior we have carried through a calculation of $\epsilon$ in which cerium-cobalt spin-spin interactions are represented by a local magnetic field $H_i$. A digital computer diagonalized the 22 × 22 matrix of the spin Hamiltonian $\frac{1}{2}g_{\perp}\beta H_i + AI_zS_z + \frac{1}{2}B(I_+S_- + I_-S_+)$ with magnetic resonance parameters appropriate for X-sites in the crystal lattice, giving the exact eigenvalues and eigenfunctions from which the angular distribution of gamma radiation has been calculated. An agreement within 2% can be obtained with ⅔ of the $^{60}$Co nuclei in X-sites and ⅓ in Y-sites if $H_i$ = 165 Oe, as in Ce−Zn nitrate, and if 1/T = 950 rather than 325, in accordance with recent work on the Ce−Mg nitrate temperature scale for a sphere. Possible sources of the remaining discrepancy are discussed. (auth)

**33258** EXPERIMENTAL STUDY OF THE EXCITATION OF THE 15.1-Mev LEVEL OF CARBON-12 BY PROTONS AT 152 Mev. ATTEMPT AT INTERPRETATION IN THE IMPULSE APPROXIMATION. de Bouard, Xavier (Faculte des Sciences, Paris). Ann. Phys. (Paris) (13), 10: 23-55 (Jan.-Feb. 1965). (In French)

The theoretical expressions for the magnitudes measured are established and the coefficients of the nucleon-nucleon scattering matrix and the nuclear form factors which they contain are calculated. The measurements of the differential cross section of excitation and polarization of the scattered protons are described and discussed. The measurement and results of the p′-γ angular correlation are discussed. The results are compared with the theoretical predictions of the impulse approximation. (J.S.R.)

**33259** BETA-GAMMA DIRECTIONAL ANGULAR CORRELATION OF Pr-144. Azuma, Toshio; Sato, Yuji (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 43-7(Mar. 1965).

Beta-gamma angular correlations of Pr-144 were measured for the transitions of 135 (β)-33 (γ), 185(β)-133(γ), and 240(β)-80(γ) kev. The angular coefficients, $A_2(\lambda_2p^2/w)$, are energy-independent of the beta rays, respectively. These beta-ray groups are concluded to be unique first forbidden. (auth)

**33260** ABSORPTION OF s-ORBIT BOUND $\pi^-$ MESONS BY HEAVY NUCLEI. Reitan, Arne (Univ. of Rochester, N. Y.). Arkiv Fys. Seminar Trondheim, No. 5, 26p.(1965).

The probability for absorption of s-orbit bound mesons ($\pi^-$) by nucleon pairs is evaluated for heavy nuclei. Pion orbits corresponding to the principal quantum numbers n = 1, 2, and 3 are considered. (auth)

**33261** INVESTIGATION CONCERNING THE DECAY SCHEME OF $Co^{56}$. Berenyi, Denes; Kazai, Lajos; Scharbert, Tibor; Vatai, Endre. At. Kozlemen., 6: 101-3(Dec. 1964). (In Hungarian)

One of the transitions in the decay scheme of $^{56}$Co has been only roughly estimated on the basis of the $\epsilon/\beta^+$ ratio, obtained from measurement of the γ radiation and the intensity of the annihilation radiation. The problem was further studied, determining the relative positron release quotient k by β-γ coincidence measurements and by comparing the area under the $\beta^+$ spectrum of $^{56}$Co with that of $^{22}$Na, taking advantage of the fact that the $\epsilon/\beta^+$ of $^{22}$Na is well known. Preliminary tests have been carried out by a third method, employing a β-γ coincidence proportional counter and a scintillation counter. The results indicated that the above ratio is 0.11 ± 0.10. The value given includes correction for electron capture. This value does not contradict the previously reached conclusions that in case of 1-forbidden transitions there is no deviation from the $\epsilon_K/\beta^+$ of the permissible transitions. Preliminary data indicate that the life time of the first excited level of $^{56}$Fe is $\tau_{\frac{1}{2}} < 10^{-10}$ sec. (TTT)

**33262** THE SPIN AND PARITY OF THE SECOND EXCITED LEVEL OF $Cs^{133}$. Scharbert, Tibor. At. Kozlemen., 6: 137-41(Dec. 1964). (In Hungarian)

Spin and parity data in the literature concerning the second, 161-kev excited level of $^{133}$Cs appear to be uncertain; therefore, this level was more closely examined. The life time of the level was measured by means of a fast-slow time-amplitude converter. The slow portion of the converter was connected to a multichannel analyzer. Satisfactory linearity of the time axis was obtained at the 14-nanosecond range. The intensity of the $^{60}$Co source was close to that of $^{133}$Ba that was used in the tests. The spin value of $5/2^+$ corresponded to the life time most closely agreeing with the measured value. (TTT)

**33263** ELECTRON NUCLEAR RESONANCE OF TRIVALENT GADOLINIUM IN THORIA. Hurrell, J. P. (Oxford Univ.). Brit. J. Appl. Phys., 16: 755-6(May 1965).

Electron nuclear double resonance measurements on gadolinium-157 substituted into crystals of thoria have provided the following values for the hyperfine interaction parameters: A = 15.806 ± 0.013 Mc, B = −0.687 ± 0.018 Mc and the nuclear magnetic moment $\mu_N$ = −0.337 ± 0.003 nuclear magnetons. (auth)

**33264** ANGULAR DISTRIBUTIONS IN GAMMA-ALPHA REACTIONS IN THE NUCLEI OF NUCLEAR EMULSIONS. Roalsvig, Jan P. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 43: 1015-19(June 1965).

The angular distributions of alpha particles from $(\gamma,\alpha)$ reactions on the nuclei of nuclear emulsions were measured. For the reaction $^{16}O(\gamma,\alpha)^{12}C$, in which the $^{12}$C nucleus is left in its ground state (J = 0⁺, T = 0), through an excited state at 12.5 Mev in $^{16}$O, the angular distribution is in agreement with a mixture of E1 and E2 interactions,

with an E2/E1 intensity ratio of 0.50. For the same reaction, through an excited state at 14.3 Mev in $^{16}O$, the angular distribution is best represented by a pure E2 interaction. (auth)

**33265** MEASUREMENT OF THE YIELDS OF $^{135}I$ AND $^{140}Ba$ IN THE FISSION OF $^{233}U$, $^{235}U$, $^{239}Pu$, AND $^{241}Pu$. Okazaki, A.; Walker, W. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 43: 1036-49(June 1965). (AECL-2191)

The fission yields of $^{135}I$ and $^{140}Ba$ were measured relative to the yields from $^{235}U$ for samples of different fissile materials irradiated in the NRU reactor in a flux of $2.7 \times 10^{14}$ neutrons/cm$^2$ sec for 24 hr. The relative $^{135}I$ contents of the samples were determined from the reactivity effect of the daughter $^{135}Xe$ in the Chalk River Pool Test Reactor using a pile oscillator. The relative concentrations of $^{140}Ba$ were determined by gamma counting of the daughter $^{140}La$. In the fission of $^{233}U$ and $^{239}Pu$, the cumulative yields of $^{135}I$ and $^{140}Ba$ are approximately 20 and 7% less than the mass-spectrometrically measured cumulative yields of $^{135}Cs$ and $^{140}Ce$ respectively. The differences are attributed to direct formation of $^{135}Xe$ and $^{140}La$. (auth)

**33266** POLARIZATION OF ELASTICALLY SCATTERED 1.33-Mev PHOTONS. Williams, R. A.; McNeill, K. G. (Univ. of Toronto). Can. J. Phys., 43: 1078-87 (June 1965).

Measurements were made as a function of angle of the polarization of 1.33-Mev gamma rays elastically scattered by lead. The analysis of the experimental data included the contribution of the L-shell electrons to inelastic Compton scattering. The results show no apparent deviation from the polarizations expected on the basis of Rayleigh and Thomson scattering. (auth)

**33267** GAMMA-GAMMA ANGULAR CORRELATION MEASUREMENTS OF THERMAL-NEUTRON-CAPTURE GAMMA RAYS IN $^{53}Cr$ AND $^{54}Cr$. Bartholomew, G. A.; Gunye, M. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 43: 1128-56(June 1965). (AECL-2197)

Coincidence and angular correlation measurements were made on $\gamma$ rays following thermal-neutron capture in separated targets of $^{52}Cr$ and $^{53}Cr$. The following spin assignments are made in $^{53}Cr$: 0.563-, 2.32-, 2.71-, and 3.62-Mev levels, $\frac{1}{2}$, $\frac{3}{2}$, $\frac{1}{2}$, and $(\frac{3}{2})$, respectively, and in $^{54}Cr$: 2.63-, 2.84-, 3.08-, 3.73-, 4.91-, and 5.30-Mev levels, 2,(0)2, 2, 1 or 2, 1 or 2, and 1, 2, or 3, respectively. Details of the decay schemes, branching ratios, and $\gamma$ multipole mixtures also are given. (auth)

**33268** LEVEL DENSITIES IN LIGHTER NUCLEI. Gilbert, A. (Columbia Univ., New York); Chen, F. S.; Cameron, A. G. W. Can. J. Phys., 43: 1248-58(July 1965)

There has been discussion in the literature as to whether the cumulative number of levels in light nuclei varies more nearly as exp(const. $E^{\frac{1}{2}}$) or exp(const. E), where E is the excitation energy. The question is examined in this paper. It is found that if one constructs step diagrams by plotting the cumulative number versus the energy, both formulas represent the data almost equally well. However, additional consideration of levels counted above neutron and proton binding energies shows that exp(const. $E^{\frac{1}{2}}$) fails badly to represent the data, whereas exp(const. E) continues to give good fits. In either case E may be measured above an arbitrary ground-state energy $E_0$. If the satisfactory formula is written in the form $\exp(E - E_0)/T$, then it is found that the dependence of the slope on mass number may be expressed in approximately the form $T^{-1} = 0.0165A$ Mev$^{-1}$, but there are significant deviations from this relation apparently related to shell structure. The intercepts $E_0$ are quite variable but are roughly clustered according to the oddness or evenness of the neutron and proton numbers of the nucleus. (auth)

**33269** ROLE OF THE SYMMETRY ENERGY IN ATOMIC MASS FORMULAS. Cameron, A. G. W.; Elkin, R. M. (Goddard Space Flight Center, New York). Can. J. Phys., 43: 1288-1311(July 1965).

Cameron has interpreted the heavy uranium mass yield curve from the Mike thermonuclear explosion as indicating that conventional atomic mass formulas do not give realistic values of neutron binding energies for neutron-rich nuclei off the valley of beta stability. Two mass formulas are constructed which differ in the treatment of the nuclear symmetry energy. In one, essentially of conventional form, very neutron-rich nuclei become unbound. In the other, of a modified exponential form, very neutron-rich nuclei remain slightly bound. The three adjustable coefficients in each formula were determined by least-squares fits to the measured masses near the valley of beta stability; the formulas fit these masses about equally well with nearly the same values of the coefficients. Additional shell and pairing corrections were determined empirically. These corrections suggest a preference for the exponential formula. Some astrophysical applications of these results are qualitatively discussed. (auth)

**33270** THE PROCESS OF NUCLEAR FISSION. Walton, G. N. Chem. Brit., 1: 202-5(May 1965).

A picture of the process of nuclear fission is presented. The saddle-point configuration, scission, and the transition from the saddle-point configuration to scission are discussed. (M.C.G.)

**33271** REMARK ON THE APPLICATION OF THE METHOD OF DISTORTED WAVES (DWBA APPROXIMATION) TO THE THEORY OF COULOMB "STRIPPING" BY (d,p) REACTIONS. Beaumevieille, Henri; Longequeue, Nicole; Longequeue, Jean-Pierre (Faculte des Sciences and Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 260: 3363-6(Mar. 22, 1965). (In French)

Applying the general theory of distorted waves (the DWBA method) to (d,p) reactions in the case of a strong Coulomb field (Coulomb stripping), by replacing the distorted partial waves by the Coulomb factors $e^{i\sigma_l}F_l$ for the initial and final states makes it possible to obtain a simplified theory. The final nucleus, considered to be formed of a neutron and the target nucleus, is described for $R > R_t$ by the radial wave function $h_l^{(1)}(ik_n r)$ and for $R_1 < R_t$ by that of the harmonic oscillator. The results in the case $l_n = 0$ are identical to those previously obtained for angular distributions, but different for the absolute value of the cross section. The formulas are also given in the case $l_n = 1$. (tr-auth)

**33272** REMARKS ON THE STUDY OF THE DISTRIBUTION OF THE PULSES OF PROTONS OR $\alpha$ PARTICLES IN THE NUCLEI WITH THE AID OF (p,2p) OR (p,p$\alpha$) REACTIONS. Yuasa, Tosisko; Hourany, Eid (Universite, Paris). Compt. Rend., 260: 3609-12(Mar. 29, 1965). (In French)

The kinematic limit for the momentum of the recoil nucleus $\vec{P}_R$ of the (p,2p) or (p,p$\alpha$) reaction, provoked in the nucleus by a proton of about a hundred Mev was formulated. The study of this limitation made it possible to evaluate its influence on the distribution of the quantities of motion of the proton or the $\alpha$ particle in the nucleus obtained with the aid of $\vec{P}_R$. (tr-auth)

**33273** INTERNAL BREMSSTRAHLUNG ASSOCIATED WITH FORBIDDEN BETA TRANSITIONS. Yem, Pham Xuan (Institut du Radium, Orsay, France). Compt. Rend., 260: 3881-2(Apr. 5, 1965). (In French)

The effect of the Coulomb potential on the internal bremsstrahlung associated with forbidden $\beta$ transitions was studied. Applications were made to the $\beta$ emitters $^{89}Sr$, $^{90}Y$, $^{91}Y$, and $^{210}Bi$. (tr-auth)

**33274** EXCITATION OF THE FIRST LEVELS OF $^6Li$ BY NEUTRONS AT 14 Mev. Merchez, Fernand; Van Sen, Nguyen; Regis, Victor; Bouchez, Robert (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 260: 3922-5(Apr. 5, 1965). (In French)

In addition to the first level at 2.18 Mev, the levels $0^+$ (3.56 Mev) and $2^+$ (4.52 Mev) were shown by $^6Li(n,n')$ scattering with the use of a time-of-flight spectrometer (total resolution: 1.3 nsec at 1 m). The elastic differential cross sections and the inelastic differential cross section leading

to the first level (2.18 Mev) were measured from 15 to 150° (L) and corrected for multiple scattering. (tr-auth)

**33275** HIGH-ENERGY GAMMA SPECTRUM EMITTED DURING THE TRANSMUTATION OF TUNGSTEN-187 INTO RHENIUM-187, OBTAINED WITH THE AID OF A LITHIUM-COMPENSATED GERMANIUM DETECTOR. Sebille, Claire; Widemann, Francois; Henck, Roland; Stab, Lucien; Siffert, Paul (Centre National de la Recherche Scientifique, Orsay, France and Centre de Recherches Nucleaires, Strasbourg). Compt. Rend., 260: 3926-9(Apr. 5, 1965). (In French)

The direct γ spectrum of the transmutation $^{187}W \rightarrow {}^{187}Re$ was studied with the aid of a lithium-compensated germanium junction. Two new transitions corresponding to the de-excitation of the same level at 880 ± 1 kev were detected. This level was interpreted as a $\frac{9}{2}$ + vibrational excitation of the ground state. (tr-auth)

**33276** EIGHT-INCH APERTURE SUPERCONDUCTING COILS. Cornish, D. N.; Williams, J. E. C. Cryogenics, 5: 132-5(June 1965). (CLM-P-51)

A mirror coil system of a size suitable for use in plasma physics experiments is being constructed. Each half of the mirror system consists of four pancake coils, each 8 in. i.d., 12 in. o.d. and 1.4375 in wide. Most of the energy content of the coils is removed from the low temperature region at quenching. This is achieved by sensing the signal developed in part of a coil and using this to trip vacuum switches in the charging circuit. The use of this mode of operation involves the generation of high voltages. Details of the coil construction including insulation, for working at 5 kv, are described. Test data and observations on the first 5 pancake coils are reported. (auth)

**33277** ON THE LIFETIME OF THE 396 kev LEVEL OF Lu-175. Ayyangar, K. M. M. S.; Lakshminarayana, V.; Jnanananda, Swami (Andhra Univ., Waltair, India). Current Sci. (India), 34: 281-2(May 5, 1965).

The decay scheme of $^{175}Yb$ principally consists of levels in $^{175}Lu$ at energies of 114, 251, and 396 kev, which are identical in the first and second levels. The isotope $^{175}Yb$ was obtained in liquid form as ytterbium chloride in dilute HCl. The time spectrum was scanned and records were made for every voltage setting. The readings after deducting the change rate were plotted. It was found that the half life of the 396-kev level was 3.32 ns. The experimental procedure was repeated and a value of 3.26 ns was obtained. There was a possibility of an error of 5% due to inherent conditions of the instrument such as those arising from calibration, and measurement of cable lengths. The average value of the half life of 396-kev level was −3.29 ± 0.16 ns. A comparison of the experimental and theoretical values showed reasonable agreement between the two. (F.J.H.)

**33278** NUCLEAR REACTIONS INDUCED BY THE ALPHA RADIATION OF POLONIUM. Eva Csongor (Lajos Kossuth Univ., Debrecen, Hungary). Fiz. Szemle, 15: 369-73(Dec. 1964). (In Hungarian)

A review of experimental investigations of alpha reactions carried out in Hungary using polonium sources is presented, with emphasis on investigations at the Institute of Nuclear Studies in Debrecen of alpha reactions with light nuclei. The reactions $^{27}Al(\alpha,n)^{30}P$, $^{10}B(\alpha,n)^{13}N$, and $^{25}Mg(\alpha,p)^{28}Al$ were among those studied. The experimental techniques used are discussed. (D.C.W.)

**33279** STUDY OF FAST-NEUTRON REACTIONS WITH REFERENCE TO THE STATISTICAL MODEL. Daroczy, Sandor; Bacso, Jozsef (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Fiz. Szemle, 15: 378-80(Dec. 1964). (In Hungarian)

Fast neutrons generated by the reactions $_1D^2 + {}_1D^2 \rightarrow {}_2He^3 + n + 3.27$ Mev and $_1T^3 + {}_1D^2 \rightarrow {}_2He^4 + n + 17.58$ Mev are used as bombarding particles for the purpose of determining the reaction cross section of the various permissible processes and the energy and angular distribution of the emitted particles. Bohr developed the intermediate-nucleus model, eliminating the contradictions presented by the optical model; the postulated process is similar to the evaporation of liquids. The course of nuclear reactions involves thus the formation of the intermediate nucleus and its decay. The problem is currently investigated at the Institute of Nuclear Studies using 2- to 3-Mev neutrons from D + D and 13- to 15-Mev neutrons from T + D reactions depending on the energy of the bombarding deuterons and the angle of the emitted neutron; 24-, 130-, 220-, 620- and 830-kev neutrons are also available from various photoneutron sources. The studies included the determination of the cross section ratios for $^{27}Al$ and $^{23}Na$, measurement of the isomeric cross section ratio for the $^{79}Br(n,\gamma)$, $^{103}Rh(n,\gamma)$ reactions, nuclear recoil effects in fast neutron reactions, and energy and angular distribution measurements with $^{7}Li$, $^{12}C$ and $^{14}N$ nuclei by means of a Wilson chamber. The excitation function of the $^{92}Mo(n,2n)^{91*}Mo$ reaction was also studied. A telescopic scintillation proton spectrometer was constructed for determining the energy and angular distribution of (n,p) reactions. (TTT)

**33280** STUDY OF THE ALPHA EMISSION OF RARE-EARTH NUCLEI. Fenyes, Tibor (Inst. of Nuclear Studies, Hungarian Academy of Sciences, Debrecen). Fiz. Szemle, 15: 384-6(Dec. 1964). (In Hungarian)

The α emission of rare-earth nuclei was examined jointly by workers at the Joint Institute at Dubna and the Institute at Debrecen, attempting to develop a theory for α decay and to explain the specific structural properties of rare-earth nuclei. A Si crystal possessing an n-p transition layer served as the detector of the semiconductor α spectrometer. The neutron-deficient rare-earth nuclei were prepared in the Dubna synchrocyclotron, separating the individual rare-earth elements by chromatography. Up to now, the Gd, Tb and Dy fractions in the spallation of Ta by 660-Mev/ protons have been investigated; preliminary data are available concerning the Ho, Er, Tm, Yb and Lu fractions. The α emission of $^{150}Tb$ was not known before; it was discovered between the $^{149}Tb$ and $^{151}Tb$ peaks of the Tb fraction. The conclusions were confirmed by the fact that the sum of energies of the 2 branches of the $^{150}Tb \rightarrow {}^{146}Sm$ closed $\alpha$-$\beta$ decay cycle agrees well with the experimental data if the experimentally obtained value of the α decay energy of $^{150}Tb$ is used. (TTT)

**33281** ANGULAR DISTRIBUTION OF NEUTRONS PRODUCED BY 40- AND 80-Mev ALPHA-PARTICLES ON A THICK TANTALUM TARGET. Wadman, William W. (Univ. of California, Berkeley). Health Phys., 11: 659-65 (July 1965). (UCRL-11375(Rev.)

The angular distribution of neutrons was measured for 40- and 80-Mev (41.2 ± 0.4 and 80 ± 1, respectively) α beams on a thick elemental tantalum target. The measurement employed six different types of threshold reaction detectors with thresholds ranging from 1.2 to 12.4 Mev. The detectors were spaced about a ring 30 cm in diameter centered above the target. The target was contained within a Faraday cup in order to measure the total beam current. High voltage applied to a guard ring which preceded the cup was used to suppress secondary electron emission. Before irradiation of the detectors, the beam was shaped and centered while being watched by closed-circuit television during the alignment. The irradiated threshold detectors were analyzed with a 3-in diam × 3-in. long NaI(Tl) crystal and a 400-channel pulse-height analyzer. The resulting data clearly indicate the existence of a prominent forward-directed neutron flux. The forward predominance was more pronounced in the higher-threshold-energy detectors. The ratio of the 70° to 0° flux decreased with the energy at which a detector's reaction cross section is in its maximum region. This type of comparison is influenced by the shapes of the cross sections as a function of energy for each type of detector. The total fast neutron yield was calculated approximately by using the $^{59}Ni(n,p)^{59}Co$ reaction and that neutron flux which would be necessary to achieve the measured activity, and correcting for the anisotropy of the forward hemisphere. The neutron yield as a function of energy appeared reasonable. (auth)

**33282** ANGULAR DISTRIBUTION OF 27 Mev DEUTERONS ELASTICALLY SCATTERED BY NITROGEN. Husain, D.; Gupta, H. M. Sen (Dacca Univ., East Pakistan). J. Nat. Sci. and Math., 4: 17-21(Oct. 1964).

An experimental elastic angular distribution of 27 Mev deuterons by nitrogen is analyzed by introducing distortion in the plane wave Born approximation treatment. Fair agreement is obtained up to about 90° with $R = 6.5$ fm and $YK = 0.15$ fm$^{-1}$. (auth)

**33283** MEASUREMENTS OF THE $^{235}U$ NEUTRON FISSION CROSS SECTION IN THE ENERGY RANGE 0.04-14 Mev. White, P. H. (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. A & B, 19: 325-42(May 1965).

The neutron fission cross section of $^{235}U$ was measured relative to the n-p scattering cross section at a number of neutron energies in the range from 0.04 to 14 Mev to an accuracy of about 3%. Hydrogen and methane gas proportional counters and a polyethylene radiator semiconductor counter were used as recoil-proton flux measuring instruments in the appropriate parts of this neutron energy range. Good agreement was obtained between the shapes of the recoil proton spectra and those calculated. The effect of neutron scattering and the loss of fission fragments in the uranium foil were investigated experimentally. At 1.0, 2.25 and 14.1 Mev, the present results agree reasonably well with a currently accepted best curve through previous measurements of this cross section (BNL-325). At energies less than 500 kev, however, the cross sections measured here are about 7% below this curve; and at an isolated measurement at 5.4 Mev, the present result is 11% below previous measurements. (auth)

**33284** ON THE EFFECT OF NUCLEON NUMBER PARITY ON THE MAGNITUDE OF RADIATIVE CAPTURE CROSS SECTIONS. Benzi, V.; Bortolani, M. V. (CNEN, Bologna). J. Nucl. Energy, Pt. A & B, 19: 364-7(May 1965).

The effect of the number parity of the nucleons in nuclei on the magnitude of radiative capture cross sections was reinvestigated, using more recent data and considering only neutron energies around 25 kev. The values obtained for the capture cross sections of even-odd nuclei were plotted as a function of proton number, together with experimental values for the capture cross sections of odd-even nuclei. No definite evidence that the former values are systematically higher than the neighboring latter values was obtained; therefore no contradiction was found with the supposition about the existence of a characteristic level from which the excitation energy of a nucleus has to be evaluated in order to estimate nuclear level densities. (D.C.W.)

**33285** INVESTIGATIONS ON IN-PILE PRODUCTION OF $Mg^{28}$ WITH THE AID OF (t,p) REACTION. Toerkoe, J. (Staatliche Atomenergiekommission, Budapest). Kernenergie, 8: 219-20(Apr. 1965). (In German)

Experiments regarding in-pile production of $^{28}Mg$ with the aid of (t,p) reaction are described, using 50% Li–50% Mg alloy as target material. The specific activities amount to 400–600 μC per g Mg, and the radiochemical purity of the final products is better than 99.5%. (auth)

**33286** $N^{14}$ INDUCED TRANSFER REACTIONS IN $Be^9$ FROM 20 TO 30 Mev. Bock, R.; Duhm, H. H.; Grosse-Schulte, M.; Ruedel, R. (Max-Planck-Institut fur Kernphysik, Heidelberg). Nucl. Phys., 70: 481-96(1965). (In German)

For the reaction $^{14}N$ on $^9Be$, angular distributions of the heavy reaction products from lithium up to carbon were measured with a dE/dx-E counter telescope at 20, 25, and 30 Mev. The angular distributions of several transitions show an exponential increase in forward and backward angles. This is explained as resulting from a transfer mechanism. The energy dependence of $\sigma(\theta)$ is in good agreement with theoretical expectation. (auth)

**33287** DETERMINATION OF THE STRENGTH FUNCTIONS $S_0$ AND $S_1$ IN Nb BY IDENTIFICATION OF THE NATURE OF NEUTRON RESONANCES. Le Poittevin, G.; De Barros, S.; Huynh, V. D.; Julien, J.; Morgenstern, J.; Netter, F.; Samour, C. (CEN, Saclay, France). Nucl. Phys., 70: 497-517(1965). (In French)

Experiments on niobium were performed with the Saclay linear accelerator using the time-of-flight method. The resonance parameters were investigated in the energy range from 30 to 4000 ev. Transmission experiments allowed identification of the p wave neutron resonances above a few hundred ev, and for the low-energy range, identification was performed by neutron capture gamma ray experiments. It is possible to determine a value of $S_1$ from individual resonance parameters at low energy ($S_1 = (5.05 \pm 1) \cdot 10^{-4}$). The $S_0$ value is $(0.35 \pm 0.06) \cdot 10^{-4}$ and confirms the low values of $S_0$ in the neighborhood of mass number 100. The total radiation widths are found to depend on the nature of the resonance: $\Gamma_\gamma = 140$ Mev for "s" levels, $\Gamma_\gamma = 230$ Mev for the "p" levels. (auth)

**33288** INELASTIC SCATTERING OF ELECTRONS ON NUCLEI AND TWO-PARTICLE NUCLEAR CORRELATIONS. Sitenko, A. G.; Simenog, I. V. (Inst. of Physics, Academy of Sciences, Kiev). Nucl. Phys., 70: 535-44(1965).

Inelastic scattering of fast electrons on nuclei and two-particle correlations in nuclei are considered. The cross section for inelastic scattering with electron transferring a definite momentum and definite energy to the nucleus is expressed directly by the spectral densities of the space-time correlation functions for nucleons in the nucleus. The correlation between nucleons in nuclei due to the Pauli principle and two-particle nucleon-nucleon interactions is investigated. Two-nucleon correlation functions are calculated for several nuclear models, viz., Fermi gas model, superfluidity model and Fermi liquid model. Collective excitations due to the residual interaction between nucleons in nuclei are considered. (auth)

**33289** FERMI LIQUID THEORY AND SPECTRUM OF EXCITATIONS OF THE $Pb^{208}$ NUCLEUS. Guman, V. N.; Birbrair, B. L. (Inst. of Physics and Tech., Leningrad). Nucl. Phys., 70: 545-52(1965).

The $^{208}Pb$ excitation spectrum is calculated in terms of Landau's Fermi liquid theory. It is shown that the region of decrease of nuclear density is essential in this problem, and the parameters of the effective forward scattering amplitude are found. The calculated excitation spectrum is in agreement with experiment. (auth)

**33290** A COMPARISON OF THE $C^{12}(He^3,p)$ AND $(He^3,n)$ REACTIONS LEADING TO ANALOGUE STATES IN $N^{14}$ AND $O^{14}$. Fulbright, H. W.; Alford, W. Parker; Bilaniuk, O. M.; Deshpande, V. K.; Verba, J. W. (Univ. of Rochester, N. Y.). Nucl. Phys., 70: 553-60(1965).

Angular distributions and excitation functions have been measured for the $^{12}C(^3He,n)^{14}O$ (ground state) and the $^{12}O(^3He,p)^{14}N$ (first excited state) reactions at energies between 6.5 and 11 Mev. Angular distributions of both protons and neutrons show strong forward peaking at all energies. At small angles the data can be fitted with the predictions of a simple plane-wave direct-interaction theory using a fixed value of $r = 5.0$ fm for the interaction radius. At larger angles the measured differential cross sections are greater than those predicted by the simple theory although they are generally much smaller than the 0° cross sections observed at the same energies. Excitation functions were obtained at a laboratory angle of 10° by the simultaneous measurement of the yields of neutrons and protons from the same target. A marked energy dependence was observed in each case. The ratio $(d\sigma_n/d\sigma_p)_{10°}$ was found to be nearly constant over the entire energy range. The ratio found was approximately two, which is the value to be expected if isobaric spin is conserved in the reaction and if Coulomb scattering and Coulomb energy effects (Q value differences), can be neglected. (auth)

**33291** THE $(He^3,\alpha)$ REACTION ON $C^{13}$. Deshpande, V. K. (Univ. of Rochester, N. Y.). Nucl. Phys. 70: 561-6(1965). (UR-875-61)

Angular distributions of alpha particles leading to the $0^+$ ground state and the $2^+$ first excited state of $^{12}C$ were obtained for the bombarding energies of 8.82, 9.44 and 10.3 Mev. Those leading to the $0^+$ second excited state were

obtained in the forward cone up to 80°. The ground state distributions show forward peaks sensitive to the bombarding energy and strong backward peaks at all energies. The first excited state distributions show strong forward and backward peaks at all energies. The second excited state distributions are forward-peaked with cross sections changing rapidly with the bombarding energy. Analysis of the data has been made in terms of the neutron pickup process by using the distorted wave Born approximation program. General features of the ground state and the first excited state distributions, including the strong backward peaks and the various secondary maxima, are found to be accounted for by the pickup process alone. The ratio of the spectroscopic factor for the transition to the first excited state to that for the transition to the ground state is found to be 1.29, in agreement with calculations of Macfarlane and French based on the Rosenfeld exchange mixture. (auth)

**33292** PRODUCTION OF HEAVY SPALLATION HYPERFRAGMENTS FROM THE INTERACTIONS OF 800 Mev/c $K^-$ MESONS WITH EMULSION NUCLEI. Renard, P. (Universite Libre, Brussels); Sacton, J.; Zakrzewski., J. Nucl. Phys., 70: 609-29(1965).

The experimental results of a detailed analysis of the interactions of 800 Mev/c $K^-$ mesons which contain hyperfragments are presented. From this analysis the mean mass and charge numbers of the heavy spallation hyperfragments were estimated. The mean momentum imparted to the observed heavy hyperfragments was found to be of the order of 1000 Mev/c. A model was considered in order to obtain some estimate of the relative contribution of the cascade and evaporation processes to the final momenta of observable heavy spallation hyperfragments. (auth)

**33293** ON THE THEORY OF MUON CAPTURE BY COMPLEX NUCLEI. [PART] II. Luyten, J. R.; Tolhoek, H. A. (Univ. of Groningen, Netherlands). Nucl. Phys., 70: 641-57(1965).

Results of shell model calculations on total muon capture rates are presented for a number of nuclei. Previous calculations on $^{16}O$ and $^{40}Ca$ are extended. It is studied in particular in which way the total capture rates depend on the depth of the finite potential well used for calculating the shell model wave functions. It is found that variations of the well depth, which cause a large variation of the fraction of final neutrons in bound or continuum states, cause only rather small variations in the total capture rates. A study is made of total capture rates in even nuclei with Z = 20 or N = 28, such as $^{40}Ca$, $^{44}Ca$, $^{50}Ti$, $^{52}Cr$, $^{56}Fe$. It is argued that the variation of the total square of the nuclear matrix elements for muon capture will be linear with Z and N in a reasonable approximation. The nuclear matrix elements and capture rates are calculated using shell model wave functions, comparing results for infinite and finite potential wells for deriving the wave functions. The results for these nuclei depend on the V or A character of the interaction, but also on details of the nuclear model used, in such a way that it seems difficult to determine a reliable value for the ratio of the V and A coupling constants from such data. (auth)

**33294** THE THEORY OF MUON CAPTURE BY COMPLEX NUCLEI. III. RADIATIVE MUON CAPTURE. Rood, H. P. C.; Tolhoek, H. A. (Univ. of Groningen, Netherlands). Nucl. Phys., 70: 658-92(1965).

Various quantities, in particular the photon spectrum and total rate, for radiative muon capture by complex nuclei are studied with the purpose of obtaining information on the coupling constants. Diagrams with muon and nucleon radiating as well as some diagrams for the induced couplings are taken into account. It is shown that the photon spectrum and the total radiative capture rate are only slightly dependent on the nuclear model, if one considers the ratio to the normal capture rate. Comparisons were made for several approximations and models, including a statistical model and harmonic oscillator wave functions. It is shown that radiative muon capture by nuclei depends strongly on the induced pseudoscalar interaction, just as for the free proton case, but the numerical results for nuclei and the free proton differ considerably. However, the fact that the results for radiative capture depend only slightly on the nuclear model implies that experiments on radiative muon capture seem to be a good method to determine the pseudoscalar interaction. Theoretical results are also derived for the circular polarization of photons emitted in radiative muon capture and for the directional distribution of the photons after capture of polarized muons. The results are presented in the form of general formulas and are evaluated numerically for a series of typical cases. The nuclei $^{40}Ca$ and $^{16}O$ are considered in particular. (auth)

**33295** FORMATION OF $Se^{77m}$, $Sr^{87m}$, $Cd^{111m}$, AND $Ba^{137m}$ BY REACTOR SPECTRUM NEUTRONS FOR USE IN ACTIVATION ANALYSIS. Kramer, Henry H.; Wahl, Werner H. (Union Carbide Corp., Tuxedo, N. Y.). Nucl. Sci. Eng., 22: 373-82(July 1965).

Metastable isomers of stable isotopes may be formed in a nuclear reactor by inelastic neutron scattering and photoexcitation of the stable isotopes, and by radiative neutron capture and (n,2n) reactions on neighboring stable isotopes. The relative importance of these reactions for the production of $^{137m}Ba$, $^{111m}Cd$, $^{77m}Se$, and $^{87m}Sr$ was evaluated by the irradiation of normal and isotopically enriched samples of the elements in the mixed radiation field of the Union Carbide Research Reactor. Radiative neutron capture is the most important source of $^{111m}Cd$, $^{77m}Se$ and $^{87m}Sr$ in samples of normal isotopic abundance. Inelastic neutron scattering is the prime contributor to the production of $^{137m}Ba$ and is of considerable importance in the production of $^{111m}Cd$. The (n,2n) reaction appears to be significant only in the production of $^{137m}Ba$. The formation of these isomers by photoexcitation by the gamma flux associated with the reactor appears to be insignificant when compared with the production by the other three processes. The cross sections determined in these investigations are generally in good agreement with available published values. Reactions for which cross sections were determined and not found in the literature include: $^{137}Ba(n,n')^{137m}Ba$, $\bar{\sigma}_f = 0.22b$; $^{111}Cd(n,n')^{111m}Cd$, $\bar{\sigma}_f = 0.14b$; $^{77}Se(n,n')^{77m}Se$, $\bar{\sigma}_f = 0.60b$; $^{87}Sr(n,n')^{87m}Sr$, $\bar{\sigma}_f = 0.12b$; $^{138}Ba(n,2n)^{137m}Ba$, $\bar{\sigma}_f = 2.0$ mb; and $^{112}Cd(n,2n)^{111m}Cd$, $\bar{\sigma}_f = 0.35$ mb. The data indicate that, for short irradiation periods in the fluxes used in these studies, the metastable isomers $^{137m}Ba$, $^{111m}Cd$, $^{77m}Se$ and $^{87m}Sr$ are the most sensitive activation-analysis indicators for these elements and give detection sensitivities in the low nanogram range. (auth)

**33296** ON CADMIUM-RATIO MEASUREMENTS FOR $U^{235}$ AND $U^{233}$ FISSION BY FISSION-PRODUCT GAMMA COUNTING. Klein, D. (Westinghouse Electric Corp., West Miffin, Penna.). Nucl. Sci. Eng., 22: 386-7(July 1965).

The cadmium ratios for $^{233}U$ and $^{235}U$ fission were determined both by direct detection of fission fragments with a fission counter and by gamma counting the fission products with a scintillation counter. The results support the use of the latter method for the measurement of cadmium ratios. (D.C.W.)

**33297** ENERGY DEPENDENCE OF THE ELASTIC SCATTERING OF ALPHA-PARTICLES ON $Ca^{40}$ NUCLEI UP TO 179°. Budzanowski, A.; Grotowski, K.; Jarczyk, L.; Lazarska, B.; Micke, S.; Niewodniczanski, H.; Strzalkowski, A.; Wrobel, Z.; (Inst. of Nuclear Physics., Krakow and Jagellonian Univ., Krakow). Phys. Letters, 16: 135-7 (May 15, 1965).

Angular distributions were measured for the elastic scattering of alpha particles on $^{40}Ca$ at 25.23 to 28.92 Mev from 22 to 170°, and the positions of maxima in the angular distribution curves are shown as a function of the energy. The energy dependence of the total cross section exhibits a broad resonance at 24.1 Mev. (L.B.S.)

**33298** NEUTRON ENERGY SPECTRA IN THE FORWARD DIRECTION FROM THE p + d REACTION AT 30 AND 50 Mev. Batty, C. J.; Gilmore, R. S.; Stafford, G. H. (National Inst. for Research in Nuclear Science, Chilton, Berks, Eng.). Phys. Letters, 16: 137-9(May 15, 1965).

Neutron energy spectra from the reaction D(p,n,)2p were measured at 0° for 30- and 50-Mev incident protons, using the time-of-flight method. The cross sections for neutrons produced in the peaks observed at the maximum energy were found to be 16.8 mb/sr at 30 Mev and 20.0 mb/sr at 50 Mev. The results are compared with the calculations of Phillips and Castillejo. (L.B.S.)

**33299** THE 1⁻ STATE AT 4.45 Mev IN $O^{18}$. Zeidman, B.; Braid, T. H. (Argonne National Lab., Ill.). Phys. Letters, 16: 139-41(May 15, 1965).

A thin Teflon target was bombarded by 21.5-Mev deuterons, and the $^3$He particles from the $^{19}F(d,^3He)^{18}O$ reaction were detected by a coincidence telescope consisting of a combination of silicon surface barrier detectors. An assignment of l = 1⁻ was made for the transition to the 4.45-Mev state on the basis of an analysis of the experimental and DWBA angular distributions leading to the ground state, 1.98-Mev level, and the 4.45-Mev level. The $^3$He energy spectra are shown together with an energy level diagram as observed l values. (L.B.S.)

**33300** INVESTIGATION OF BORON 10 AND BORON 11 BY ELASTIC ELECTRON SCATTERING AT 180°. Goldemberg, J.; Isabelle, D. B.; Stovall, T.; Vinciguerra, D.; Bottino, A. (Universite de Paris, Orsay, France). Phys. Letters, 16: 141-3(May 15, 1965).

The elastic scattering of electrons at 180° was investigated in order to measure the magnetic form factors of $^{10}$B and $^{11}$B nuclei over a momentum range from $q^2 = 0.5$ fm$^{-2}$ to $q^2 = 3.1$ fm$^{-2}$. The results are tabulated. It was found that the $^{11}$B form factor can be explained by the single-particle shell model whereas the $^{10}$B form factor cannot be explained by such a simple model. The importance of octupole magnetic terms in the elastic scattering is shown. (L.B.S.)

**33301** COLLECTIVE AND SPHERICAL STATES IN $O^{16}$. Kelson, I. (Weizmann Inst. of Science, Rehovoth, Israel and Israel Atomic Energy Commission, Soreq Research Establishment, Yavne). Phys. Letters, 16: 143-7(May 15, 1965).

A model is presented in support of the suggestion that some nuclei may be regarded as having a dual nature in this respect: they have both spherical and collective energy levels, competing and interfering with one another. In particular, a simple interpretation of the low spectrum of the doubly magic nucleus $^{16}$O is obtained on the basis of the model, and the results show good agreement with experiment. (L.B.S.)

**33302** THE DEFORMATION OF $Mg^{27}$ AND THE SPINS OF THE LOW-LYING STATES. Glower, R. N. (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Phys. Letters, 16: 147-9(May 15, 1965).

A detailed study was made of $^{27}$Mg from the reactions $^{26}$Mg(d,p) at 10 Mev and $^{25}$Mg(t,p) at 12 Mev. Absolute cross sections were also measured for (d,p) reactions on $^{24}$Mg, $^{26}$Mg, and $^{28}$Si. Evidence obtained from angular distributions and spectroscopic factors favors the spin assignments of $\frac{3}{2}^+$, $\frac{5}{2}^+$, and $\frac{5}{2}^+$ for the 0.98-, 1.69-, and 1.94-Mev excited states of $^{27}$Mg, respectively. The spin assignments in conjunction with the gamma transitions between the states indicate that the deformation is oblate, similar to that of $^{29}$Si. (L.B.S.)

**33303** ANGULAR DISTRIBUTION OF THE POLARIZATION OBTAINED BY THE SCATTERING ON $^{12}$C, $^{28}$Si, AND $^{58}$Ni OF VECTORIALLY POLARIZED 22 Mev DEUTERONS. Arvieux, J. F.; Beurtey, R.; Garin, A.; Mikumo, T.; Papineau, A.; Thirion, John (SPNME-CEN, Saclay, France). Phys. Letters, 16: 149-51(May 15, 1965). (In French)

Experiments were carried out using a system of four Li-doped Si junction detectors separated by dE/dx surface barrier detectors, enabling deuterons to be detected at 16 angles simultaneously. Curves are shown, giving the angular distribution of asymmetry of 22-Mev vectorially polarized deuterons scattered by the ground and first excited $2^+$ states of $^{12}$C and $^{28}$Si and by the ground state of $^{58}$Ni.(M.J.T.)

**33304** THE QUADRUPOLE MOMENT OF THE $2^+$ STATE AT 122 kev IN $Sm^{152}$. Goldring, G. (Weizmann Inst. of Science, Rehovoth, Israel); Smilansky, U. Phys. Letters, 16: 151-3(May 15, 1965).

An experiment was previously performed to determine the quadrupole moment of the $2^+$ state in $^{152}$Sm in a precision measurement of the excitation function for Coulomb excitation with back scattered oxygen ions. A detailed and rigorous calculation was performed to study the dependence of the excitation process on both Q ($2^+$) and the transition probability B(E2; $2^+ \rightarrow 4^+$). A comparison of the calculated results with an analysis of the experimental results establishes the value of $Q(2^+)$ as $(-1.8 \pm 0.6) \times 10^{-2}$ 4 cm$^2$, which is in good agreement with the rotational value. (L.B.S.)

**33305** MEASUREMENT OF THE GYROMAGNETIC RATIO OF THE 84 kev $2^+$ STATE IN YTTERBIUM 170. Tippie, J. W.; Scharenberg, R. P. (Case Inst. of Tech., Cleveland). Phys. Letters, 16: 154-5(May 15, 1965).

An analysis is made of measurements of the gyromagnetic ratio and mean life of the 84-kev $2^+$ rotational state in $^{170}$Yb using the pulsed beam technique. The precession of the Coulomb excited nuclei in an external magnetic field was detected by observing the de-excitation gamma radiation as a function of time. The resultant precession and the attenuation coefficient of the magnitude of the angular distribution are shown as functions of time. A value of $g = 0.33 \pm 0.02$ and mean life $\tau = 2.28 \pm 0.07$ was obtained. (L.B.S.)

**33306** HYPERFINE STRUCTURE ANOMALY AND QUADRUPOLE MOMENT OF $Eu^{151,153}$. Winkler, R. (Technische Universitat, Berlin). Phys. Letters, 16: 156-7(May 15, 1965). (In German)

An investigation of the $(4f^7)6s$ Eu−II groundstates ($a^9S_4$, $a^7S_3$) is extended, whose hfs splitting originates from the unpaired 6s-electrons. Magnetic line-splitting factors were found for two transitions in the natural $^{151}$Eu and $^{153}$Eu composition, and are tabulated along with previously found transitions. The hfs anomaly was found to be $-(0.66 \pm 0.25)\%$, which is in good agreement with theoretical and other experimental results. Error limits of the B-factors of the $6p^7P_{3,4}$ terms were also found, and the results are tabulated. The quadrupole splitting factors for the P-term were obtained from the Eu-I spectrum $\lambda 7584 (z^{10}P_{3\frac{1}{2}} - C^{10}S_{3\frac{1}{2}})$, from which the quadrupole moments of $^{151}$Eu and $^{153}$Eu were found. (L.B.S.)

**33307** ON HYPERFINE STRUCTURE ANOMALY OF STABLE Re-ISOTOPES. Krause, H.; Krebs, K.; Winkler, R. (Technische Universitat, Berlin). Phys. Letters, 16: 158-9(May 15, 1965). (In German)

The hyperfine structure anomaly due to unpaired s-electrons in $^{185}$Re and $^{187}$Re was determined from an exact measurement of the hyperfine splitting factors, using a photoelectric recording interferometer. The measured A-factors are tabulated along with 1B-factors obtained from other results, and the hfs anomaly was found to be $+(0.03_3 \pm 0.03_3)\%$. No quadrupole splitting was observed for the ground state of $^{185}$Re and $^{187}$Re. (L.B.S.)

**33308** LOW ENERGY NEUTRON RESONANCES OF PALLADIUM. Coceva, C.; Corvi, F.; Giacobbe, P.; Stefanon, M. (CNEN, Ispra, Italy). Phys. Letters, 16: 159-61(May 15, 1965).

Experiments were performed on natural palladium with a fast chopper for neutron energies up to 150 ev. For the transmission measurements the neutron detector consisted of four lithium loaded glass scintillators, each followed by a photomultiplier tube and a single channel analyzer. Transmission data were used to analyze the resonances up to 63 ev. Three weak resonances were found at 27.8, 42.8, and 63 ev, and analyzed by the area method; eight other resonances were analyzed by the shape method. Low-energy capture gamma-ray spectra were measured with a Pd sample for seventeen resonances up to 150 ev, using two NaI(Tl) crystals in coincidence. Two types of spectra were found corresponding to the decay of the compound nuclei $^{106}$Pd and $^{109}$Pd, allowing the isotopic assignments to all the resonances except the one at 113 ev. The capture

gamma time-of-flight spectra were measured by detection of single and coincident gamma rays, which revealed another weak resonance at 44.8 ev. The spin was determined for twelve resonances of $^{105}$Pd, which is in agreement with other experimental values. (L.B.S.)

**33309** ON THE VECTOR AND AXIAL VECTOR NUCLEAR MATRIX ELEMENTS IN THE MUON CAPTURE PROCESS. M. Rho (Centre d'Etudes Nucleaires, Saclay, France and Universite de Paris, Orsay, France). Phys. Letters, 16: 161-3(May 15, 1965).

The ratio of the axial vector matrix element to the vector matrix element $\lambda$ in the muon capture process is examined in a general manner with restriction to the one particle–one hole picture. The nuclear hamiltonian consists of the two-body central forces, and it is assumed that the total proton and neutron intrinsic spins are separately zero and $T = T_z = 0$ in the initial nuclear state into which the muon is captured. In the absence of spin-dependent forces, the result was found to be $\lambda = 1$. The upper and lower limits of the ratio $\lambda$ were evaluated for $^{16}$O, and were found to be approximately 1.13 and 0.94 respectively. It is concluded that in general the spin-dependent forces do not play a significant role for the ratio $\lambda$ for the properties assumed for the initial state. (L.B.S.)

**33310** AN OCTUPOLE TRANSITION IN $^{28}$Si. R. Nordhagen, M. Hoffman, F. Ingebretsen, and A. Tveter (Universitet, Oslo). Phys. Letters, 16: 163-5(May 15, 1965).

Angular correlation measurements on the 1199 kev $^{27}$Al(p,$\gamma$)$^{28}$Si resonances, which yield $J = 3$ for the 6.88 $\gamma$ transition, are reported. An inconclusive argument for the odd parity assignment to the 6.88 level is given, which requires that the ground and first excited state transitions be E3 and E1 transitions, respectively. (L.B.S.)

**33311** EXCITATION OF $\Delta T_z = 2$ ANALOG STATES BY DOUBLE CHARGE EXCHANGE SCATTERING OF PIONS. S. Barshay (Rutgers State Univ., New Brunswick, N. J.) and G. E. Brown. Phys. Letters, 16: 165-7(May 15, 1965).

Detailed calculations and angular distributions for reactions leading to the analog state in double charge exchange scattering of pions from nuclei are reported. The process of collective excitation by a high-energy pion of the member of a high-isotopic-spin nuclear multiplet with z-component, $T_z + 2$, starting from the lower-energy member with z-component, $T_z$, is analyzed. Calculations were carried out for $^{48}$Ca, the two neutrons in the $j = f_{\frac{7}{2}}$ shell transforming into protons, for incident mesons of 210 Mev laboratory kinetic energy, and the results are shown. (L.B.S.)

**33312** ELASTIC ELECTRON SCATTERING ON HELIUM 4. J. P. Repellin, P. Lehmann, J. Lefrancois, and D. B. Isabelle (Universite de Paris, Orsay, France). Phys. Letters, 16: 169-70(May 15, 1965).

An experiment was performed in which electrons were elastically scattered from a $^4$He target at 477 Mev. Form factors were measured and were compared with other experimental form factors whose behavior was fitted by a Gaussian function that is the Fourier transform of the charge distribution that is expected assuming a harmonic oscillator model for the $^4$He nucleus. Evidence is presented for a departure from this model. (L.B.S.)

**33313** ISOBARIC SPIN IN HEAVY NUCLEI. L. A. Sliv and Yu. I. Kharitonov (Ioffe Inst. of Physics and Tech., Lenigrad). Phys. Letters, 16: 176-8(May 15, 1965).

The admixture of different isotopic spin in heavy nuclei is calculated using a realistic nuclear model and accurate approximations for the Coulomb effect. The intensity admixture of states with isospin $T = T_0 + 1$ is shown as a function of z for different nuclei. (L.B.S.)

**33314** p-p AND p-n FINAL-STATE INTERACTIONS IN SEVERAL THREE-BODY REACTIONS. Tombrello, T. A.; Bacher, A. D. (California Inst. of Tech., Pasadena). Phys. Letters, 17: 37-9(June 15, 1965).

Evidence for strong final-state nucleon interactions is investigated. These reactions $^3$He(d,t)2p, $^3$He($^3$He,$\alpha$)2p, and $^3$He(p,d)2p are investigated for the proton final-state interaction. For the proton-neutron final-state interaction the reactions $^3$He(d,$^3$He)pn, and $^4$He(d,$\alpha$)pn were examined. (J.F.P.)

**33315** GIANT RESONANCES, SIZE RESONANCES, AND ECHOES. McVoy, K. W. (Univ. of Wisconsin, Madison). Phys. Letters, 17: 42-5(June 15, 1965).

Neutron cross sections appear to exhibit three similar but distinct phenomena. One is the giant resonance taken to mean a group of nearby energy levels which derive their "neutron strengths" from a single particle resonance, another called single-particle resonance is due to the trapping of a particle in a potential well, and the last, echo, is due to constructive interference in the external region between two parts of a plane wave which passes through and around a transparent but refracting object. The phenomena are discussed, and it is pointed out that they have no bearing on the giant dipole resonance for photon absorption. (J.F.P.)

**33316** EXCITATION OF TWO-PHONON STATES OF $^{60}$Ni BY INELASTIC ALPHA-PARTICLE SCATTERING. Kumabe, I.; Ogata, H.; Tomita, S.; Inoue, M.; Okuma, Y. (Kyoto Univ.). Phys. Letters, 17: 45-6(June 15, 1965).

Investigation of the angular distributions for the two-phonon triplet states of $^{60}$Ni with good energy resolution was made using a beam of 34.4-Mev alpha particles to bombard an enriched thin target of $^{60}$Ni. The difference among the phases of the angular distributions corresponding to the two-phonon triplet states may presumably be due to the difference of the relative magnitudes of the direct and multiple excitation processes. (J.F.P.)

**33317** EXCITED $0^+$ LEVEL OF $^4$He. "MIRAGES." Baldin, A. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 17: 47-8(June 15, 1965).

The problem of an excited state of $^4$He with an energy of about 20 Mev and the quantum numbers of the ground state is considered. It is shown that a simple generalization of the effective-range approximation permits an explanation of the existence of this state, its quantum numbers, its position and width, and allows a prediction of analogous levels in other nuclei. The available experimental data on the $0^+$ excited level of the $^4$He is explained without recourse to model representations. (J.F.P.)

**33318** NUCLEAR $\gamma$-RAY ABSORPTION CROSS SECTION OF $^{40}$Ca IN THE GIANT RESONANCE REGION. Dolbilkin, B. S.; Korin, V. I.; Lazareva, L. E.; Nikolaev, F. A. (Lebedev Inst. of Physics, Moscow). Phys. Letters, 17: 49-50(June 15, 1965).

The gamma absorption cross section of $^{40}$Ca was measured with the 260-Mev electron synchrotron using the total absorption method with a 9-channel pair magnetic spectrometer as a detector. The integrated nuclear absorption cross section in the energy range studied, 11-28.5 Mev, is (920 ± 100) Mev-mb. This agrees, within experimental accuracy, with the value obtained from the sum rule for electric dipole transitions. The integrated cross section in the energy interval 16-~24 Mev is equal to about 60% of the total integrated cross section. (J.F.P.)

**33319** MEASUREMENT OF INTERNAL CONVERSION COEFFICIENTS OF MÖSSBAUER NUCLEI. Isaak, G. R.; Isaak, U. (Univ. of Birmingham, Eng.). Phys. Letters, 17: 51-2(June 15, 1965).

Measurements of the absolute Mössbauer absorption cross sections were used to deduce the total internal conversion coefficient of the 14.4-kev level of $^{57}$Fe. The method of measuring these coefficients is to excite the level of interest by $\gamma$ ray resonance radiation and to measure the probability of de-excitation by $\gamma$ radiation. This total internal conversion coefficient $\alpha$ is found independent of any assumptions to be 9.2 ± 0.5 and under certain assumptions to be $8.9 \leq \alpha \leq 9.8$, which is consistent with previously reported values. (J.F.P.)

**33320** SIMPLE PICTURE OF REVERSE ROTATION OF GAMMA-RAY ANGULAR PATTERN IN INELASTIC

ALPHA-PARTICLE SCATTERING. Verhaar, B. J.; Tolsma, L. D. (Technische Hogeschool, Eindhoven, Netherlands). Phys. Letters, 17: 53-5(June 15, 1965).

Several experimental studies of the $2^+ \rightarrow 0^+$ $\gamma$ angular pattern in inelastic $\alpha$ particle scattering by even-even nuclei have shown that rotation of the $\alpha$ scattering angle is accompanied by a rapid reverse rotation of the $\gamma$ pattern. The interpretation of Inglis (Phys. Letters, 10: 336 (1964)) which supplemented the formal DWBA analysis, is extended and some inconsistencies with experiment are eliminated. (J.F.P.)

**33321** ANALOGUES OF EXCITED STATES IN $^{119}$Sn. Allan, D. L.; Jones, G. A.; Morrison, G. C.; Taylor, R. B.; Weinberg, R. B. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 17: 56-8(June 15, 1965).

The variation of yield with bombarding energy of proton inelastic scattering to excited states in $^{119}$Sn in the range of excitation 2.5–4.5 Mev was previously observed. It was also found that a state in $^{119}$Sn frequently decays to a state or states in $^{119}$Sn at an excitation roughly equal to the excitation of the isobaric analog state in $^{119}$Sn, indicating similar sequences of simply connected states in an even-even nucleus and its neighboring even-odd nucleus. Since this work was concerned with rather highly excited states in $^{119}$Sn, the study is extended to lower lying states and to lower bombarding energies. It is found that the strongest resonances in the excitation of the 1.23 Mev $2^+$ state in $^{118}$Sn occur at an energy corresponding to states near 1.1 Mev in the analog nucleus $^{119}$Sn, and those in the excitation of the 2.32 Mev $3^-$ state in $^{118}$Sn at an energy corresponding to states near 2.5 Mev in $^{119}$Sn. The suggested direct link between states in $^{118}$Sn and $^{119}$Sn therefore occurs in the lower lying states. A simple model illustrating this connection between states is developed. (J.F.P.)

**33322** STUDY OF SECOND EXCITED $2^+$ STATES OF SOME EVEN-EVEN NUCLEI BY BETA-GAMMA ANGULAR CORRELATIONS. Raghavan, R. S.; Grabowski, Z. W.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 139: B1-8(July 12, 1965). (COO-1420-111)

Beta-gamma directional correlations of several first-forbidden $\beta$ transitions leading to second excited states of even-even nuclei ($\beta_2$ transitions) were studied. The energy-dependence of the $\beta$ directional correlation factor $A_2(\beta)$ in the $\beta$-$\gamma$ correlation function $W(\theta) = 1 + A_2(\beta)A_2(\gamma)P_2(\cos\theta)$ was measured for the $\beta_2$ transitions of $^{76}$As, $^{122}$Sb, $^{128}$I, $^{124}$Sb, and $^{140}$La, and the reduced $\beta$ coefficient $R_2(W) = A_2(\beta)/(\Lambda_2 p_2/W)$ was determined. In all cases $R_2(W)$ was found to be very different from $R_1(W)$, the reduced $\beta$ factor describing the $\beta_1$ transition to the first excited state of the daughter nucleus. The results indicate that the relative magnitudes of the nuclear $\beta$-matrix elements in the $B_1$ transition and in the $\beta_2$ transition are significantly different, although the ft values are very similar. The implication of these experimental results for the structure of first and second excited states of even-even spherical nuclei is discussed. (auth)

**33323** ENERGY LEVELS OF $Bi^{211}$. Mead, R. O.; Draper, J. E. (Univ. of California, Davis). Phys. Rev., 139: B9-16(July 12, 1965).

The gamma-ray spectrum from the decay of $^{211}$Pb was studied with NaI crystals (using singles, gamma-gamma coincidence, and sum-coincidence techniques) and with a germanium semiconductor detector. The energies and relative gamma-ray intensities are reported for 16 transitions in $^{211}$Bi. The energy and relative intensity of 5 internal-conversion electron lines were measured with a precision magnetic beta spectrometer. From the gamma-ray and internal-conversion transition energies and the gamma-gamma coincidence measurements a consistent level diagram for $^{211}$Bi is proposed which has levels at 404.84 ± 0.04, 766.34 ± 0.07, 831.83 ± 0.04, 1020 ± 3, 1076 ± 3, 1104 ± 2, 1188 ± 2, and 1265 ± 2 kev. (auth)

**33324** IMPLICATIONS OF UNSTABLE COLLECTIVE MODES FOR THE NUCLEAR-MATTER GROUND STATE. Warke, Chindhu (Univ. of California, San Diego, La Jolla). Phys. Rev., 139: B17-23(July 12, 1965).

The general stability conditions of the plane-wave Hartree-Fock approximation of nuclear matter are derived in the approximation of small collective-excitation momentum. The relation of the random-phase-approximation method of determining these conditions to the Fermi-sphere-deformation method is pointed out. In the same approximation, it is shown that the stability conditions do not depend on the shape of the potential. (auth)

**33325** SEARCH FOR HIGHER ORDER EFFECTS IN ALLOWED BETA TRANSITIONS. Grabowski, Z. W.; Raghavan, R. S.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 139: B24-8(July 12, 1965).

The $\beta$-$\gamma$ directional correlations of several allowed $\beta$ transitions with unusually large ft values (log ft > 7) were measured. Effects of second-forbidden $\beta$ components are expected to manifest themselves in small observable anisotropies if second-forbidden matrix elements are not reduced appreciably by those nuclear-structure effects that cause the reduction of the allowed matrix elements. The experimental results for the anisotropy factor $A_{22}(W)$ in the $\beta$-$\gamma$ directional correlation function $W(\theta) = 1 + A_{22}(W)P_2(\cos\theta)$ are: $^{22}$Na($W_0$ = 1.69, log ft = 7.4); $A_{22}(\overline{W} = 1.8) = -0.001 \pm 0.005$; $^{56}$Co($W_0$ = 3.88, log ft = 8.6), $A_{22}(\overline{W} = 3.3) = -0.001 \pm 0.003$; $^{124}$Sb($W_0$ = 2.23, log ft = 7.7), $A_{22}(\overline{W} = 2.0) = +0.002 \pm 0.003$; $^{134}$Cs($W_0$ = 2.3, log ft = 8.9), $A_{22}(\overline{W} = 1.9) = +0.001 \pm 0.003$; $^{160}$Tb($W_0$ = 2.1, log ft = 8.1), $A_{22}(\overline{W} = 1.9) = +0.013 \pm 0.007$. Except for the highly deformed $^{160}$Tb, no evidence of interference effects with second-forbidden $\beta$ components was found, indicating that whatever the mechanism that reduces the allowed matrix elements it somehow also reduces the second-forbidden matrix elements. The small anisotropy found in $^{160}$Tb may be a result of some K selection rule effect or may be caused by a competing forbidden $\beta$ transition. Evidence for the existence of such a $\beta$ transition (which, however, is very difficult to fit into the established $^{160}$Tb decay scheme) is given. (auth)

**33326** INTERACTION OF 350-kev POLARIZED NEUTRONS WITH ORIENTED $^{165}$Ho NUCLEI. Wagner, R. (Oak Ridge National Lab., Tenn.); P. D. Miller, Tamura, T.; Marshak, H. Phys. Rev., 139: B29-46(July 12, 1965). (ORNL-P-1048)

The interaction of polarized and unpolarized 350-kev neutrons with oriented and unoriented $^{165}$Ho nuclei was investigated in order to study the effect of nuclear deformation and to search for a possible spin-spin interaction. The ORNL 3-Mv pulsed and bunched Van de Graaff proton beam was used in conjunction with a time-of-flight spectrometer. The $^7$Li(p,n) reaction at a laboratory angle of 51° provided a source of 55% polarized, 350-kev neutrons. Using the NBS transportable $^3$He refrigerator, a single crystal of $^{165}$Ho metal was cooled to 0.34°K and a nuclear polarization of approximately 15% was obtained with a superconducting split solenoid. The differential cross section for unpolarized 350-kev neutrons, elastically scattered from unoriented $^{165}$Ho nuclei, was measured in a cylindrical geometry and is in good agreement with the results of a coupled-channel calculation. The total cross section of unoriented $^{165}$Ho was measured between 300 and 400 kev. A coupled-channel calculation of the total cross section using the same optical-model parameters as those which fitted the angular distribution is found to agree very well with these data. To investigate the spin-spin interaction, measurements were made of the transmitted intensities with the target nuclei polarized alternately parallel and antiparallel to the direction of neutron polarization. The observed change in intensity, $(-0.11 \pm 0.32)\%$, and the observed total cross section of 7.94 b imply a change in cross section of $(+30 \pm 85)$ mb, where the plus sign corresponds to a larger cross section for the parallel orientation. Comparison of this result with that of the coupled-channel calculation indicates that if the spin-spin interaction in the optical-model potential is written as $-V_{ss}(\sigma \cdot I)$ times a Saxon form factor, then $V_{ss}$ lies between −130 and +280 kev. Since the $^{165}$Ho nucleus is highly deformed, a transmission measurement was made to determine the change in cross section between a highly oriented and a nearly unoriented target. The transmission of the

target decreased by (1.3 ± 0.4)% for the higher orientation value, which corresponds to a cross-section increase of 350 ± 100 mb. This deformation effect on the total cross section is also in good agreement with that derived from the coupled-channel calculation. The deformation parameter $\beta$ used in the optical-model potential was +0.3, in agreement with other measurements. (auth)

**33327** COMPARISON BETWEEN PHASE SHIFT AND COMPLEX POTENTIAL DESCRIPTIONS OF ELASTIC SCATTERING. Alster, Jonas (Univ. of Washington, Seattle and Univ. of California, Berkeley); Conzett, Homer Phys. Rev., 139: B50-4(July 12, 1965). (UCRL-11975)

The equivalence between parametrized phase-shift and complex-potential analyses of the elastic scattering of strongly absorbed particles is discussed. Specific comparisons are made using computer analyses of alpha-particle scattering data. The relative merits of the two analyses are pointed out. (auth)

**33328** DENSITY EFFECT ON ENERGY VERSUS RANGE OF FISSION FRAGMENTS IN GASES. Fulmer, C. B. (Oak Ridge National Lab., Tenn.). Phys. Rev., 139: B54-5(July 12, 1965). (ORNL-P-979)

The density effect on specific energy loss of fission fragments in gases is discussed. Previously reported range-versus-energy data for median-mass light and heavy fission fragments in $H_2$, He, air, and Ar are corrected for saturation of the density effect. (auth)

**33329** MODEL FOR CALCULATING INDEPENDENT RADIOCHEMICAL YIELDS FROM THE THERMAL-NEUTRON FISSION OF $U^{235}$. Ferguson, J. M.; Read, P. A. (Naval Radiological Defense Lab., San Francisco). Phys. Rev., 139: B56-65(July 12, 1965).

An empirical model was devised to predict independent radiochemical yields from the thermal-neutron fission of $^{235}U$. As much as possible, experimental data were used as a basis for the calculation. The resulting model is best described as a method of correlating the available mass, energy, and yield data in order to predict other quantities, particularly independent radiochemical yields. Calculated radiochemical mass yields, independent yields, kinetic energies, and neutron emission probabilities are compared with experiment. The agreement is generally good. However, the calculation shows a large discrepancy in the energy balance at symmetric fission. Also, it indicates that less than half of the observed gamma-ray energy per fission is accounted for by gamma-ray emission following neutron emission. The results also suggest that even-even fragments are preferentially formed. (auth)

**33330** POLARIZATION OF PHOTONEUTRONS PRODUCED FROM DEUTERIUM BY 2.75-Mev GAMMA RAYS. Jewell, R. W.; John, W.; Sherwood, J. E ; White, D. H. (Univ. of California, Livermore). Phys. Rev., 139: B71-9(July 12, 1965). (UCRL-12347)

An earlier experiment was modified by the addition of a spin-precessing solenoid to permit an improved measurement of the polarization of the neutrons from photodisintegration of deuterium. Monoenergetic 2.75-Mev gamma rays were obtained from $^{24}Na$ and the neutron polarization was analyzed by scattering from magnesium. The polarization normal to the reaction plane was measured for $\gamma$-n laboratory angles from 30 to 150°. Empirical corrections were derived for neutron scattering in the deuterium source as well as in the Mg analyzer. Within the errors the polarization is found to be symmetric about 90°, consistent with the absence of noncentral forces. The magnitude is, however, (12 ± 7)% smaller than that calculated by Kramer from E1-M1 interference using effective-range theory. A major source of uncertainty in the experiment is the analyzing power of Mg. For a $\gamma$-n laboratory angle of 90°, the neutron polarization was also determined in the direction of the incident gamma ray. The result $P < 0.01$ is consistent with the conservation of parity in the reaction. (auth)

**33331** ENERGY-LEVEL STRUCTURE OF $Ca^{41}$ FROM THE $Ca^{40}(d,p)Ca^{41}$ REACTION. Belote, T. A ; Sperduto, A.; Buechner, W. W. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 139: B80-91(July 12, 1965). (MIT-2098-104)

The level structure of the nucleus $^{41}Ca$ was studied by the $^{40}Ca(d,p)^{41}Ca$ reaction at an incident deuteron energy of 7.00 Mev. Angular distributions were measured for 120 levels below an excitation energy of 6.83 Mev, and those levels showing forward-stripping angular distributions were analyzed using the distorted-wave Born approximation. Results on excitation energies, captured-neutron orbital angular momenta, and transition strengths are given for these levels. The data were further analyzed in terms of the shell model and the unperturbed single-particle level positions with their corresponding spectroscopic factors were determined. For the $(1f_{7/2})$ single-particle level at $E_x = 0.0$ Mev, S = 1.0; $(2p_{3/2})$, $E_x = 2.07$ Mev, S = 1.22; $(2p_{1/2})$, $E_x = 4.13$ Mev, S = 1.17; $(1f_{5/2})$, $E_x = 5.50$ Mev, S = 0.48; $(1g_{9/2})$, $E_x \geq 4.98$ Mev, S = 0.07; $(2d_{3/2})$, $E_x > 6.8$ Mev, S = 0.15; and $(3s_{1/2})$, $E_x > 6.8$ Mev, S = 0.05. The possible role of $(1d_{3/2})$ and $(2s_{1/2})$ shell-model hole states is also discussed. (auth)

**33332** NUCLEAR SPECTROSCOPIC STUDIES WITH HIGH-ENERGY BORON IONS. Sachs, M. W.; Chasman, C.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev., 139: B92-109(July 12, 1965).

High-energy boron beams were used in studies of proton and deuteron transfer reactions involving a carbon target. These studies, involving examination of reactions leading to isolated states in the residual nuclei, were undertaken to obtain information on the transfer mechanism at high energies, and to ascertain the extent to which such reactions might serve as probes for certain one- and two-nucleon states in the residual nuclei involved. The proton transfer reactions $^{12}C(^{11}B,^{10}Be)^{13}N$ and $^{12}C(^{10}B,^{9}Be)^{13}N$, at bombarding energies of 115.5 and 105 Mev, respectively, are observed to populate only a few levels in $^{13}N$. The first excited state, which is known to have a large proton width, is not one of these levels. It is suggested that this reflects an angular-momentum mismatch which acts to inhibit the S-wave proton transfer which would populate this state. The deuteron transfer reaction $^{12}C(^{11}B,^{9}Be)^{14}N$, at 115.5 Mev bombarding energy, is also observed to populate only a few levels in the residual nucleus $^{14}N$. Arguments are presented favoring direct population of $^{14}N$ levels having $^{12}C + (d_{5/2})^2$ and $^{12}C + (d_{5/2},d_{3/2})$ two-particle configurations. In particular, the observed strongly populated levels at approximately 9- and 13-Mev excitation were tentatively identified as the J = 5, T = 0 and J = 4, T = 0 members of the above multiplets, respectively. The existing intermediate-coupling calculations pertaining to $^{14}N$ are in excellent accord with such a description but suggest significant $(p_{1/2},f_{7/2})$ admixtures in the latter state. The angular distributions of the strong groups in all reactions are smoothly varying, exponential functions of angle. These have been fitted, in terms of a surface-diffuseness parameter, using a simple diffraction model. The diffuseness obtained is in excellent accord with other results in the same mass and energy range. By comparing the present data with those on other reactions involving the same incident system, qualitative conclusions are drawn regarding fractional parentage in the incident systems. In both single- and two-nucleon situations, the experimental results are compared in detail with corresponding data from $^{3}He$- and $^{4}He$-induced reactions. (auth)

**33333** CHARGE FORM FACTORS OF $^{3}H$ AND $^{3}He$. Carl Werntz (Catholic Univ. of America, Washington, D. C. and Naval Ordnance Lab., White Oak, Md.) and H. S. Valk. Phys. Rev. Letters, 14: 910-12(May 31, 1965).

The large difference in the charge form factors of the mirror nuclei $^{3}H$ and $^{3}He$ is discussed. Previous suggestions that attributed this difference to the presence of an S state of mixed spatial symmetry or to the admixture of a $T = 3/2$ state are considered. It is indicated that neither of these states would seem to be a likely source for the difference. The maximum admixture of $T = 3/2$ is shown to be about 0.1% and it is pointed out that the greater strength of the central singlet nucleon–nucleon interaction relative to the central triplet causes an admixture of the mixed symmetry state of the wrong sign. (C.E.S.)

**33334** LARGE-ANGLE NEUTRON SCATTERING FROM LEAD AT 7 Mev. C. D. Zafiratos, T. A. Oliphant, J. S. Levin, and L. Cranberg (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 14: 913-15(May 31, 1965). (LA-DC-7102)

New data were obtained from measurements of the spectra of scattered neutrons using the pulsed-beam time-of-flight spectrometer associated with the large electrostatic generator. The reaction $O(d,n)^3He$ furnished neutrons with an energy spread of 150 kev. Over-all time resolution was 2.5 nsec full width at half-maximum and a flight path of 3 meters. The maximum angle of observation of 165° was defined by mechanical considerations. The scattering data for $^{206}Pb$ and $^{209}Bi$ were compared with predictions of the optical model. (M.O.W.)

**33335** PROTON-CORE EXCITATION IN THE GROUND STATE OF $O^{18}$. J. R. Erskine, R. E. Holland, R. D. Lawson, M. H. Macfarlane, and J. P. Schiffer (Argonne National Lab., Ill.). Phys. Rev. Letters, 14: 915-18(May 31, 1965).

The description of the measurement and interpretation of the reactions $^{18}O(^3He,d)^{19}F$ to the $\frac{1}{2}^-$ first excited state of $^{19}F$ is included. The interpretation of this negative-parity state as a hole in the 1p shell implies that it can be populated in a direct reaction only if there are $p_{\frac{1}{2}}$ holes in the $^{18}O$ ground state. (M.O.W.)

**33336** BLOCKING EFFECTS IN THE EMERGENCE OF CHARGED PARTICLES FROM SINGLE CRYSTALS. Gemmell, D. S.; Holland, R. E. (Argonne National Lab., Ill.). Phys. Rev. Letters, 14: 945-8(June 7, 1965).

The detection of charged particles emitted from atomic nuclei occupying sites within the crystal lattice is reported. Two experimental techniques were used. Firstly, photographic emulsions were employed to examine the spatial distribution of protons, deuterons, and alpha particles scattered from a silicon single crystal and of protons scattered from a germanium crystal. Secondly, a position-sensitive semiconductor was used to perform two-parameter pulse-height analyses of both the energies and positions of charged particles scattered at wide angles from the silicon single crystal. (M.O.W.)

**33337** OBSERVATION OF RECOILLESS EMISSION OF $^{61}Ni$ GAMMA RAYS FOLLOWING COULOMB EXCITATION. Seyboth, Dietrich; Obenshain, Felix E.; Czjzek, Gordon (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 14: 954-7(June 7, 1965).

The recoilless emission of gamma rays from $^{61}Ni$ after the 67.4-kev energy level was populated by Coulomb excitation is reported. Projectiles used for excitation were 25-Mev oxygen ions. A study of the Mössbauer effect is included. (M.O.W.)

**33338** MÖSSBAUER EFFECT FROM COULOMB-EXCITED LEVELS IN $Fe^{57}$. Lee, Y. K.; Keaton, P. W. Jr.; Ritter, E. T.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Phys. Rev. Letters, 14: 957-8(June 7, 1965).

A large Mössbauer effect in $^{57}Fe$ due to Coulomb excitation is reported. Results indicate that despite the large recoil energy of the nucleus following the Coulomb excitation, the Mössbauer fraction is essentially undiminished. Coulomb excitation was produced by a 1.5 μamp beam of 3-Mev alpha particles, and the target and absorber were 1.9 mg/cm² of 91% enriched $^{57}Fe$. (M.O.W.)

**33339** RECOIL EFFECTS IN HEAVY-ION TRANSFER REACTIONS. Dodd, L. R.; Greider, K. R. (Yale Univ., New Haven). Phys. Rev. Letters, 14: 959-62(June 7, 1965).

Data obtained in previous heavy-ion experiments involving both single-particle and cluster transfer at energies well above the Coulomb barrier reflect a discrepancy between diffraction theory and experiment. An explanation is obtained with a sharp-cutoff diffraction model, where both finite-range effects and recoil effects are included. (M.O.W.)

**33340** PRODUCTION OF VERY HEAVY ELEMENTS IN THERMONUCLEAR EXPLOSIONS-TEST BARBEL. Phys. Rev. Letters, 14: 962-5(June 7, 1965). (LA-DC-7064)

The Barbel device for producing heavy elements contained a $^{238}U$ target in its high-neutron-flux region. Information was obtained by alpha, beta, and fission measurements on the individual elements isolated by certain procedures. In addition data on the abundance of isotopes up through mass 250 were obtained by mass spectrometric measurements on plutonium, americium, and curium fractions. A table of data is included. (M.O.W.)

**33341** BETA-NEUTRINO ANGULAR CORRELATION IN $Sb^{122}$. Palathingal, J. C. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Letters, 14: 983-5(June 14, 1965).

An experimental determination of the beta-neutrino angular correlation of the $2^- \rightarrow 2^+$ first forbidden nonunique beta transition from $^{122}Sb$ to the first excited state of $^{122}Te$ is presented. Results indicate that the $^{122}Sb$ decay takes place predominantly through an axial vector interaction. (M.O.W.)

**33342** EXISTENCE OF LIGHT DOUBLE HYPERNUCLEI. Tang, Y. C. (Univ. of Minnesota, Minneapolis); Herndon, R. C. Phys. Rev. Letters, 14: 991-5(June 14, 1965).

An investigation of the existence of particle-stable, light double hypernuclei is included. Results are reported by using a variational method on the double hypernuclear systems ${}_{\Lambda\Lambda}Z^A$ with A = 3 to 6. (M.O.W.)

**33343** PRODUCTION OF ANTIPROTONS VIA NUCLEAR MOTION. Dorfan, D. E. (Columbia Univ., New York); Eades, J.; Lederman, L. M.; Lee, W.; Ting, C. C.; Piroue, P.; Smith, Stuart; Brown, J. L.; Kadyk, J. A.; Trilling, G. H. Phys. Rev. Letters, 14: 995-9(June 14, 1965).

A series of measurements are made of the reaction p + Cu → $\bar{p}$ + residue, using protons of energies near and below threshold for antiproton production via the free particle reaction $p + (\frac{p}{p}) \rightarrow p + p + (\frac{p}{p}) + \bar{p}$. The main objective is to find the distribution function $P_T(W_0)dW_0$, i.e., the probability of observing a c.m. total energy $W_0$ when the bombarding energy in the laboratory system is T. Assumptions that dynamics enters simply via a threshold function and that a nucleon momentum distribution is a satisfactory model for the mechanism by which the nuclear energy is contributed to the reaction are made. (M.O.W.)

**33344** SEARCH FOR MASSIVE PARTICLE. Dorfan, D. E.; Eades, J.; Lederman, L. M.; Lee, W.; Ting, C. C. (Columbia Univ., New York). Phys. Rev. Letters, 14: 999-1003(June 14, 1965).

Negative results are reported of a search for particles of mass $3 \leq m \leq 7$ Bev produced by collisions of 30-Bev/c protons with Be and Fe nuclei. The experiment was sensitive to quarks or particles of any charge $q \geq \frac{2}{3}$ e. (M.O.W.)

**33345** OBSERVATION OF ANTIDEUTERONS. Dorfan, D. E.; Eades, J.; Lederman, L. M.; Lee, W.; Ting, C. C.; (Columbia Univ., New York). Phys. Rev. Letters, 14: 1003-6(June 14, 1965).

A high-transmission mass analyzer designed to search for unitary-symmetry triplets was used to observe the production of antideuterons in 30-Bev proton-beryllium collisions. A search for antitritons in the momentum interval near 9.0 Bev/c is also reported. (M.O.W.)

**33346** POSSIBLE EVIDENCE OF DIPOLE-QUADRUPOLE INTERACTION IN $As^{75}$. Fielder, D. S.; Le Tourneux, J.; Min, K.; Whitehead, W. D. (Univ. of Virginia, Charlottesville). Phys. Rev. Letters, 15: 33-5(July 5, 1965).

Observation of a structure in the photoneutron-production cross section of the spherical nucleus $^{75}As$, which may be ascribed to the interaction of the dipole and quadrupole vibrations, is reported. The experimental cross section is compared with the theoretical cross section based on the dipole-quadrupole interaction model. (M.O.W.)

**33347** MAGNETIC INELASTIC SCATTERING OF NEUTRONS BY A FERROMAGNETIC CRYSTAL. Subramaniam, R.; Kharadze, G. A. (Atomic Energy Establishment, Trombay, India). Proc. Indian Acad. Sci., Sect. A; 61: 202-18(Apr. 1965).

The energy spectrum of thermal neutrons inelastically scattered by a ferromagnetic crystal is investigated. The method of double-time temperature-dependent Green's functions is used. Formulas are derived for the line width and for an asymmetry parameter leading to a deviation from the Lorentzian form. The results are discussed and compared with earlier work. Special attention is paid to the question of the deviation of the energy distribution from the purely Lorentzian form. (auth)

**33348** HYPERFINE STRUCTURE IN GROUND MULTIPLETS OF $^{17}O$ AND $^{19}F$. Harvey, J. S. M. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 285: 581-96 (May 11, 1965).

The hyperfine structure coupling constants of the ground $^3P$ multiplet of $^{17}O$ were measured in a paramagnetic resonance experiment with a sample of enriched oxygen gas. The results confirm the values of $a_2$ and $b_2$ reported previously by Kamper, Lea & Lustig (1957). Measurements were also made on the excited level of the ground $^2P$ multiplet of $^{19}F$. An analysis of the magnetic hyperfine constants in the ground multiplets of $^{17}O$ and $^{19}F$ shows that in neither case do they yield consistent values for the two parameters $\langle r^{-3} \rangle$ and $|\psi(0)|^2$ usually associated with magnetic hyperfine structure. All measurements of hyperfine structure in these multiplets are consistent, however, with the requirements of LS coupling theory which introduce a third parameter into the magnetic hyperfine operator. The discrepancy is attributed to polarization effects, other than spin polarization of the core s electrons, brought about by the exchange interaction between electrons. (auth)

**33349** REMARKS ON THE STANDARDIZATION OF $^{22}Na$. Brinkman, G. A.; Aten, A. H. W., Jr.; and Veenboer, J. Th. (Inst. of Nuclear Physics Research, Amsterdam). Radiochim. Acta, 4: 55-8(May 1965).

Due to the complex nature of its decay scheme the calibration of $^{22}Na$ was somewhat complicated. The corrections required to obtain an accuracy of 1 or 2% were however, fairly simple. (auth)

**33350** SOME EXPERIENCES IN THE FIELD OF NUCLEAR PHYSICS. PART II. Angelo di Loreto (Universita, Rome). Riv. Ing. Nucl., 2: 609-14(Nov.-Dec. 1964). (In Italian)

A series of determinations and fundamental operations are described, correlated with tables and graphical data to instruct the engineer in the common usages in the field of nuclear physics. The measurement of the half life of $^{56}Mn$, spectrum of $^{60}Co$, and calculation of the absorption cross-section for thermal neutrons in Ag are reported. (J.S.R.)

**33351** HALF-LIFE OF $^{130}Te$ DOUBLE BETA-DECAY. Takaoka, Nobuo; Okano, Jun (Osaka Univ.). Shitsuryo Bunseki, 12: 195-210(Mar. 1965). (In Japanese)

The half life of $^{130}Te$ double $\beta$ decay was determined by a mass-spectrometric method. The samples were old tellurium ores obtained from Oya gold mine in Japan. The amount of $^{130}Xe$ occluded in the tellurium ores as the daughter of $^{130}Te$ double $\beta$ decay was measured by an isotope dilution method using $^{128}Xe$ as a spike. The mass spectrometer used is 20-cm radius, 90° single focusing type. The detection limit for xenon under static operation is about $10^5-10^6$ atoms. The spike $^{128}Xe$ used was prepared by neutron irradiation of KI in a nuclear reactor. $^{130}Xe$ occluded in tellurium ores was extracted by heating in an electric furnace at about 700-1200°C. Pure calcium metal, titanium-filament, tungsten-filament, and a dry ice trap were used to remove impurity gas components. In the mass spectra, excesses of $^{129}Xe$, $^{130}Xe$, and $^{131}Xe$ over normal xenon were found, and the excess of $^{130}Xe$ was predominant. On the assumption that the $^{130}Xe$ excesses obtained were entirely due to the $^{130}Te$ double $\beta$ decay, the half lives of $^{130}Te$ double $\beta$ decay were calculated to be $10.7 \times 10^{20}$ years, $5.38 \times 10^{20}$ years, $7.29 \times 10^{20}$ years, and $8.27 \times 10^{20}$ years for four samples. The half life of $^{130}Te$ double $\beta$ decay is $(7.91 \pm 1.11) \times 10^{20}$ years on the average. This value agrees fairly well with the result $(1.4 \times 10^{21}$ years) of Inghram-Reynolds, the result $(3.3 \times 10^{21}$ years) of Hayden-Inghram, and the theoretical value $(2 \times 10^{21 \pm 2}$ years) of Primakoff-Rosen, based on two-neutrino theory. The xenon age of the tellurium ores, which was used for calculation of the above half-lives, was determined from the age of porphyrite expected to be about the same as the tellurium ores. The age of porphyrite was determined to be $(9.06 \pm 0.29) \times 10^7$ years by a K-Ar method with the same mass spectrometer used for the $^{130}Xe$ measurement. The ratio of $^{129}Xe$ excess to $^{131}Xe$ excess obtained was about 1.6, and the ratio estimated from the neutron absorption cross sections for $^{128}Te$ and $^{130}Te$ and their abundance ratios is about 0.5. These ratios are not in agreement. So these excesses in $^{129}Xe$ and $^{131}Xe$ seem to be produced in part by neutron absorptions of $^{128}Te$ and $^{130}Te$ and in part by different processes. (auth)

**33352** COLLECTIVE OSCILLATIONS IN NUCLEI WITH FORMS CLOSE TO THE SPHERICAL. Ovcharenko, V. I. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 10: 486-96 (May 1965). (In Ukrainian)

The collective oscillations in even-even nuclei about an equilibrium form close to the spherical are considered within the confines of an adiabatic approximation, i.e., on the assumption that the frequency of collective oscillations is much less than the frequencies associated with the motion of separate nucleons. The potential of these oscillations is taken in the form $\frac{1}{2}C\beta^2 + \beta \cdot \chi(\cos 3\gamma)$, where $\beta$ and $\gamma$ are variables characterizing the shape of the nucleus. The first three terms of the expansion of the function $\chi(\cos 3\gamma)$ into a series of Legendre polynomials of $\cos 3\gamma$ are taken into consideration, which introduces three parameters into the theory. The consideration is conducted with the aid of perturbation theory, in which the potential $H' = \beta \cdot \chi(\cos 3\gamma)$ is considered a small perturbation. Expressions are obtained for the energies and probabilities of the electric quadrupole transitions with an accuracy to the terms of the second orders in H'. The results show that for a complete explanation of all characteristics of low excited states of even-even nuclei in the region under consideration it is not enough to take into account only the small non-sphericity of the equilibrium form of these nuclei, and that it is evidently essential to allow for non-adiabaticity as well. (auth)

**33353** THE PREPARATION OF SOURCES BY VACUUM EVAPORATION. Su, Hong-yuan; Sun, Yung-chun; Nee, Wei-ling. Wu Li Hsueh Pao, 21: 526-30(Mar. 1965). (In Chinese)

Thin and uniform sources are always needed in $\beta$-spectroscopy. For this purpose, an apparatus of vacuum evaporation was designed, by means of which sources such as $^{114}In$, $^{198}Au$, and $^{153}Sm$ were prepared. Sources of $^{114}In$ were prepared, both by drop evaporation and vacuum evaporation and were measured with a double focusing beta spectrometer and a double-lens beta spectrometer. Their internal conversion spectra were compared. The advantage of the method of vacuum evaporation is obvious. In addition, the $^{198}Au$ K-conversion line of the 411.8-Kev gamma ray and the $^{153}Sm$ K, $L_I$, $L_{II}$, $L_{III}$ conversion lines of the 69.67-Kev gamma ray were measured with the double-focusing $\beta$-spectrometer. (auth)

**33354** COHERENT EFFECT IN WEAK-DEFORMED NUCLEAR FIELD. Pao, Cheng-kwang. Wu Li Hsueh Pao, 21: 531-41(Mar. 1965). (In Chinese)

The coherent effect inherent in a particle-particle pair or particle-hole pair which is moving in a rotating weak-deformed nuclear field was investigated. The low-lying $0^+$, $2^+$, $4^+$ states of $^{18}O$ and the $0^-$, $1^-$, $2^-$, $3^-$ states of $^{16}O$ were calculated accordingly. Comparison with the corresponding wave functions by the classical shell model calculation shows that there is much similarity between them. Some preliminary conclusions were obtained as follows: the main components in nuclear forces are the $P_2$ force plus certain other forces with coherent properties; the former is equivalent to a rotating deformed field, while the latter is essential in all the calculated states except the $0^-$ state. (auth)

**33355** ON THE STRUCTURE OF THE COHERENT ENERGY STATES IN NUCLEI $F^{19}$ AND $Ne^{20}$. Yu, Youwen; Chang, Tsung-hua; Yu, Min. Wu Li Hsueh Pao, 21: 541-5(Mar. 1965). (In Chinese)

A spatially symmetrized wave function of the two-particle system was previously proposed. A wave function for three- and four-particle systems with the same symmetrical property is now proposed. Comparing these wave functions with the shell model wave functions calculated by Flowers and Redlich, similarity between them is observed, and it is found that the squares of the overlap integrals of the corresponding wave functions are greater than 80%. (auth)

**33356** ON THE INVESTIGATION OF NEUTRON FISSION SPECTRA. Yeh, Hsuan-hua; Wang, Te-yu. Wu Li Hsueh Pao, 21: 546-59(Mar. 1965). (In Chinese)

With consideration of the fact that fission neutrons are evaporated from moving fragments, general formulas are shown for the spectrum and angular distribution of neutrons $N(E,\theta)$, and the effect of the three different absorption cross sections on the neutron spectrum and angular distribution is considered in detail. It is shown that the form of the spectra near $0^0$ relative to the direction of fragment motion depends more sensitively on the absorption cross section. Numerical calculations are carried out of neutron spectra for determined angles of $^{252}Cf$ (spontaneous fission) and $^{235}U$ (thermal neutron fission), and comparisons of calculated and experimental data are made. Results show that 1) the neutron spectra calculated according to the optical model or the constant absorption cross sections agree well with the experimental data; 2) the ratio of the average number of neutrons from light fragments to the number of neutrons from heavy fragments (1.45 for $^{235}U$; 1.16 for $^{252}Cf$) is in agreement with other calculations, but is greater than directly measured values; 3) the theoretical neutron spectra at 90° are 15 to 30% less than the corresponding experimental values. (tr-auth)

**33357** INVESTIGATION OF THE $Lu^{167} \rightarrow Yb^{167} \rightarrow Tu^{167}$ DECAY CHAIN. K. Ya. Gromov, A. S. Danagulyan, A. T. Strigachev, and V. S. Shpinel (Joint Inst. for Nuclear Research, Dubna, USSR and Moscow State Univ.). Yadern. Fiz., 1: 389-99(Mar. 1965). (In Russian)

Conversion electron spectra of $^{167}Lu$ and $^{167}Yb$ were studied, using a Danish type $\beta$ spectrograph with resolution 0.08–0.11%. Data on $^{167}Yb$ decay were obtained, more complete than previously known. An intensity balance in the decay scheme of $^{167}Yb$–$^{167}Tm$ was performed. 26 transitions are attributed to $^{167}Lu$; of these 13 were found for the first time. The multipolarities of 11 transitions belonging to the decay of $^{167}Lu$ were determined. The decay scheme $^{167}Lu \rightarrow {}^{167}Yb$ is given. (auth)

**33358** MASS DIFFERENCES IN NEAR-TO-MAGIC NUCLEI. E. E. Sapershtein and M. A. Troitskii. Yadern. Fiz., 1: 400-6(Mar. 1965). (In Russian)

Masses of even nuclei are studied, using the Green function method. An equation is obtained for magical-plus-two-particle nuclei, recalling the Schroedinger equation for two particles in a potential well. It is shown that the effective attraction in nuclei is a sum of two effects: weak repulsion inside the nucleus and strong attraction in the peripheral region, i.e., there is no pairing in nuclear matter. (auth)

**33359** EXCITATION OF NUCLEAR ROTATIONAL STATES IN NUCLEON SCATTERING. S. I. Drozdov. Yadern. Fiz., 1: 407-13(Mar. 1965). (In Russian)

Total and differential cross sections for the scattering of nucleons and deuterons on nuclei with the excitation of rotational states are calculated, using the adiabatic approximation in the optical model for nonspherical nuclei. The calculation is performed by numerically integrating a system of radial wave equations. Results of the calculations are given. (auth)

**33360** THE INFLUENCE OF SURFACE VIBRATIONS IN STRONGLY DEFORMED NUCLEI ON THE CHARACTER OF THEIR DIPOLE EXCITATION. S. F. Semenko (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 1: 414-19(Mar. 1965). (In Russian)

The influence of surface $\gamma$ vibrations in spheroidal nuclei on the shape of their giant dipole resonance is studied. The broadening of the transverse maximum, due to the $\gamma$ vibrations, is estimated. For the values $\overline{\gamma} = 0{,}2$, $\hbar\Omega \approx 0.5-0.8$ Mev for the amplitude and frequency of the $\gamma$ vibrations, this broadening is equal to ~0.8–0.5 Mev. The effect of Raman scattering into $\gamma$ vibrational states is estimated. Results of the vibration modes are compared to the corresponding estimations of the nonaxial rotator model. (auth)

**33361** LEVEL DENSITIES AND THERMODYNAMIC FUNCTIONS OF ATOMIC NUCLEI WITH CONSIDERATION OF PAIRING CORRELATION EFFECTS. Yu. T. Grin and V. M. Strutinskii. Yadern. Fiz., 1: 420-5(Mar. 1965). (In Russian)

Thermodynamic characteristics, level densities, and moments of inertia of deformed even nuclei are calculated as functions of the excitation energy, taking into account nucleon pairing correlations in nuclei. It is shown that the nuclear level density for given neutron binding energies can be made to agree with its theoretical value by choosing the neutron and proton pairing correlation energies within the experimental accuracies with which they are determined. (auth)

**33362** ACCOUNT OF INITIAL AND FINAL STATE INTERACTIONS IN DIRECT NUCLEAR REACTIONS BY THE DIAGRAM SUMMATION METHOD. E. I. Dolinskii, L. D. Blokhintsev, and A. M. Mukhamedzhanov (Moscow State Univ.). Yadern. Fiz., 1: 426-35(Mar. 1965). (In Russian)

A method is proposed for calculating the amplitude M(s,t) of a direct nuclear reaction of the type $1 + 2 \rightarrow 3 + 4$, taking initial and final state interactions into account (the diagram summation method). The amplitude M(s,t) is constructed on the basis of the Born amplitude B(s,t), described by one or several Feynman diagrams, in which initial and final state interaction effects are neglected. The diagram summation method is compared with the distorted wave and dispersion methods. (auth)

**33363** QUADRUPOLE GIANT RESONANCE IN HEAVY NUCLEI. A. A. Lushnikov and M. G. Urin. Yadern. Fiz., 1: 436-42(Mar. 1965). (In Russian)

The theory of finite Fermi systems is applied to investigate the quadrupole giant resonance in heavy nuclei. The dependence of various resonance characteristics on the quasiparticle interaction is clarified. The monopole resonance is briefly discussed. (auth)

**33364** EXCITATION OF $La^{139}$ AND $Pr^{141}$ LEVELS IN INELASTIC NEUTRON SCATTERING. V. A. Bukarev and V. I. Popov (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 1: 443-7(Mar. 1965). (In Russian)

Spectra of the $\gamma$ radiation following the inelastic scattering of 1 to 2 Mev neutrons on $^{139}La$ and $^{141}Pr$ nuclei were investigated. Gamma-transition schemes are given, explaining the measured spectra. The excitation cross sections of various levels are determined, including two previously unknown levels of $^{139}La$. (auth)

**33365** NEUTRON SPECTRA AND ANGULAR DISTRIBUTIONS IN (d,n) REACTIONS ON MEDIUM ATOMIC WEIGHT NUCLEI. V. V. Okorokov and D. L. Tolchenkov (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 1: 448-51(Mar. 1965). (In Russian)

Neutron spectra and angular distributions in (d,n) reactions on separated $^{44}Ca$ and $^{42}Ca$, $^{54}Fe$ and $^{56}Fe$, $^{60}Ni$, $^{62}Ni$, and $^{64}Ni$, $^{63}Cu$ and $^{65}Cu$, $^{66}Zn$ and $^{68}Zn$ isotopes were obtained. The ITEP cyclotron was used as a source of 11.7-Mev deuterons. The measurements were performed by the time-of-flight method, using a multichannel analyzer, with the approximate channel width 1 nsec. The spectra were taken with low resolution and the thickness of the targets was 9 to 12 mg/cm$^2$. The intensities, angular distributions, and giant peaks in the nuclear potential well are identical when passing from one isotope with given Z to another. This indicates that the same one-particle levels in the proton shell are excited. Intensive proton capture to the ground state of the product nucleus and to near-lying levels was observed. (auth)

**33366** NEUTRON POLARIZATION IN (d,n) STRIPPING REACTIONS WITH $l_p = 1$. Babenko, N. P.; Bibichev, B. A.; Konstantinov, I. O.; Moskalev, A. P.; Nemilov, Yu. A. Yadern. Fiz., 1: 452-5(Mar. 1965). (In Russian)

The angular dependence of the neutron polarization in the reaction $^{14}N(d,n)^{15}O$ (ground state) with $l_p = 1$ was measured for deuteron energy $E_d = 3.7 \pm 0.3$ Mev. The dominating role of deuteron wave distortion is demonstrated. (auth)

**33367** ON MULTIPLE COULOMB EXCITATION OF NUCLEI. Berson, I. (Inst. of Physics, Academy of Sciences, Latvian SSR). Yadern. Fiz., 1: 456-60(Mar. 1965). (In Russian)

The dependence of the excitation probabilities of rotational states in even-even nuclei on the parameter $\xi$ is investigated. It is shown that the account of first order corrections in $\xi$ is sufficient only for small values of q. The results are compared with experimental data for $^{152}Sm$. (auth)

**33368** ENERGY CHARACTERISTICS OF FRAGMENTS CREATED IN THE FISSION OF $Th^{232}$ AND $U^{238}$ NUCLEI BY CHARGED PARTICLES. Bochagov, B. A.; Vasil'ev, S. S.; Semenchuk, G. G.; Solyakin, G. E. (Ioffe Inst. of Physics and Tech., Leningrad and Moscow State Univ.). Yadern. Fiz., 1: 461-70(Mar. 1965). (In Russian)

The kinetic energies of pair fragments created in the fission of $^{232}Th$ and $^{238}U$ by $\alpha$ particles and deuterons with energies 26.4 and 13.2 Mev respectively were studied with the help of semiconductor detectors. The experiments were performed at the cyclotron of the Moscow State University Nuclear Physics Research Institute. The compound nuclei $^{234}Pa$, $^{238}U$, $^{240}Np$, and $^{242}Pu$ had approximately the same excitation energies, equal to 21 to 22 Mev. It was found that the most probable total kinetic energy of pair fragments $\bar{E}_{II}$ increases according to Terrell systematics. It should be noted that the most probable kinetic energy of the group of heavy fragments $\bar{E}_T$ increases considerably as the number A of the fissile nucleus increases, whereas the most probable kinetic energy of the group of light fragments $\bar{E}_\pi$ changes only slightly. The dependence of $E_{II}$ on the mass ratio R for fixed values of R has a maximum $E_{max}$ at $R^*$, slightly lower than the most probable mass ratio; this corresponds to thermal neutron fission. However, the dependence $E_{II}(R)$ has some peculiarities in comparison with thermal neutron fission. The function $E_{II}(R)$ does not decrease as steeply for $R > R^*$ and $R < R^*$ as in fission due to thermal neutrons. The difference $E_{max} - E_{II}(R = 1) = \Delta E_1 = 8 - 10$ Mev and $E_{max} - E_{II}(R = 1.8) = \Delta E_2 = 5 - 7$ Mev, whereas in neutron fission these differences are equal to 30-40 Mev and 20-25 Mev respectively. Furthermore $\Delta E_1$ does not depend on the angle $\varphi$ between the divergence direction of the fragments and the direction of the beam of charged particles, whereas $\Delta E_2$ increases as $\varphi$ changes between 90° and 45°. It is suggested that such a behavior of $E_{II}(R)$ is connected with the influence of the excitation energy of the fissile nucleus and the momentum of the incident particle. (auth)

**33369** ANGULAR DISTRIBUTION OF FRAGMENTS IN THE PHOTOFISSION OF $U^{238}$ AND $Th^{232}$ BY $\gamma$-RAYS FROM THE REACTION $F^{19}(p,\alpha\gamma)O^{16}$. Soldatov, A. S.; Aleksandrova, Z. A.; Gordeeva, L. D.; Smirenkin, G. N. Yadern. Fiz., 1: 471-5(Mar. 1965). (In Russian)

Results of measurements of the fragment angular distribution in the photofission of $^{238}U$ and $^{232}Th$ are given. They were obtained by detecting of fission events, according to the traces the fragments leave when passing through glass. The obtained results are in contradiction to the results of Forkman and Johansson and Lazareva et al., but in agreement with all other data known, in showing that the contribution of the fission cross section for quadrupole absorption of $\gamma$ quanta to the total photofission cross section is small in the studied energy region above 6 Mev and does not exceed a few percent. (auth)

**33370** ENERGY DEPENDENCE OF THE ANGULAR ANISOTROPY OF $\gamma$-RADIATION, ACCOMPANYING THE FISSION OF $U^{235}$. Petrov, G. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 1: 476-8(Mar. 1965). (In Russian)

The energy dependence of the angular anisotropy of photon emission in the fission of $^{235}U$ by thermal neutrons was determined for angles 0 and 90° between the directions of the $\gamma$ quantum and fission fragment, on the basis of the measured $\gamma$ spectra. For energies higher than 1.7 Mev the $\gamma$ quanta are emitted isotropically. The anisotropy in the region 0.25-0.75 Mev is somewhat larger than in the neighboring regions. (auth)

**33371** ON THE EXISTENCE OF INTERNUCLEON POTENTIAL NON-CONSERVING SPATIAL PARITY. Abov, Yu. G.; Krupchitskii, P. A.; Oratovskii, Yu. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 1: 479-89(Mar. 1965). (In Russian)

The universal four-fermion weak interaction theory predicts the existence of a space-parity nonconserving nucleon-nucleon potential. Previous attempts to detect this potential were unsuccessful. The asymmetry coefficient in the angular distribution of $\gamma$ quanta emitted by the $^{114*}Cd$ nucleus following the capture of polarized neutrons was measured. The $\gamma$ quanta were recorded by two identical scintillation spectrometers with NaI crystals. They picked out $\gamma$ quanta of the $^{114*}Cd$ ground-state transition for angles $\theta_1 = 0°$ and $\theta_2 = 180°$ with respect to the neutron spin. The influence of the instrumental instability was minimized by rapid comparisons of effects induced by polarized and unpolarized neutrons, using a rotating depolarizator. Instrumental asymmetries were excluded by performing experiments with two opposite neutron spin directions and also by measurements with interchanged spectrometers. A number of control experiments was performed, and their results show that there is no neglected instrumental asymmetry. The asymmetry coefficient proved to be equal to $a = -(3.7 \pm 0.9)10^{-4}$ and hence $F \approx 4 \cdot 10^{-7}$. (auth)

**33372** THE ALPHA-SPECTRUM OF $Pu^{241}$ AND LEVELS OF THE $U^{237}$ NUCLEUS. Baranov, S. A.; Gadzhiev, M. K.; Kulakov, V. M.; Shatinskii, V. M. Yadern. Fiz., 1: 557-61(Apr. 1965). (In Russian)

The $\alpha$-spectrum of $^{241}Pu$ was investigated with the help of a magnetic $\alpha$-spectrograph. An analysis of the $\alpha$-spectrum revealed the existence of 10 fine structure groups in the $\alpha$-radiation of the isotope. Several were found for the first time. The energy level scheme of the $^{237}U$ nucleus is constructed. The existence of two bands in this scheme with the initial quantum characteristics $^1/_2{}^+(631)$ and $^5/_2{}^+(622)$ is demonstrated. (auth)

**33373** SEPARATION OF ANGULAR VARIABLES IN EQUATIONS FOR THE EFFECTIVE FIELD IN SPHERICAL NUCLEI. Gaponov, Yu. V.; Krainov, V. P. Yadern. Fiz., 1: 573-80(Apr. 1965). (In Russian)

Equations for the radial part of the effective field in spherical nuclei are obtained and discussed for the case of electromagnetic transitions. The effective fields are found for electric $\gamma$-transitions, magnetic allowed and l-forbidden transitions and also for $\beta$-decay. (auth)

**33374** COMPRESSIBILITY AND POLARIZABILITY OF NUCLEAR MATTER. Tyapin, A. S. Yadern. Fiz., 1: 581-7(Apr. 1965). (In Russian)

Arguments are given indicating that it is necessary to take the compressibility and polarizability of nuclear matter into account, when analyzing the experimental data on the mass and charge distributions in nuclei and also when writing semiempirical nuclear mass formulas. These effects are very important e.g., in calculations of the height of fission barriers. (auth)

**33375** A SIMPLE DESCRIPTION OF THE ANGULAR DISTRIBUTION OF DECAY PRODUCTS FROM A COMPOUND NUCLEUS AFTER A DIRECT NUCLEAR REACTION. Strutinskii, V. M. Yadern. Fiz., 1: 588-95(Apr. 1965). (In Russian)

A classical model is considered for the angular distribution of compound nucleus decay (or fission) products in mixed nuclear reactions, when the compound nucleus is created in a direct nuclear reaction. A comparison with the corresponding quantum mechanical calculations shows that the model is sufficiently accurate. The role of the direct reaction mechanism is discussed. (auth)

**33376** EFFECT OF PAIRING ON THE PENETRATION OF TWO PARTICLES THROUGH A CENTRIFUGAL BARRIER. Goldanskii, V. I. (Inst. of Chemical Physics, Academy of Sciences, USSR). Yadern. Fiz., 1: 596-9(Apr. 1965). (In Russian)

It is shown in the quasiclassical approximation that the pairing of protons and neutrons in nuclei can lead to the following two effects in the penetration of two nucleons through a centrifugal barrier: The penetrability of the barrier increases in comparison with the penetration of two independent particles; The barrier holds the virtual singlet state of the pair of nucleons up to the distance $r_0 = \sqrt{l(l+1)}\hbar/\sqrt{m\epsilon_0}$ ($\epsilon_0 \approx 70$ kev—the energy of the virtual $^1S_0$ level), i.e., up to $10^{-11}$ cm in many realistic cases. Both effects must be observed in two-proton radioactive decays and in proton or neutron pair transfer processes in heavy ion reactions. The last case nucleon pair transfer is the nuclear analogy of the Josephson effect in superconductivity. (auth)

**33377** THE QUANTUM GREEN FUNCTION METHOD IN NUCLEAR REACTION THEORY. Zhivopistsev, F. A. (Moscow State Univ.). Yadern. Fiz., 1: 600-6(Apr. 1965). (In Russian)

A relation is obtained between the S-matrix of the nuclear reaction $A + \alpha \rightarrow B + \beta$ and the corresponding generalized Green function G, similar to the Lehmann-Zimmermann-Symanzik reduction formula in quantum field theory. The elastic and inelastic scattering of nucleons on nuclei is investigated in the low-energy region. Expressions for the T-scattering matrix are obtained without any assumptions as to the weakness of the interaction and the mechanism of the nuclear reaction. The interference between the direct process and the formation of a compound nucleus by one collision is investigated. Two-particle excitation effects in nuclear reactions are considered. (auth)

**33378** ENERGY DISTRIBUTION OF RECOIL NUCLEI IN EVAPORATION. Denisov, F. P. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 1: 607-11(Apr. 1965). (In Russian)

Energy distributions of recoil nuclei are calculated for the evaporation of two, three, five and ten nucleons from a nucleus. It is shown that for a small number of evaporating nucleons the form of the distribution differs significantly from the Gaussian one and depends on the nucleon energy distribution. (auth)

**33379** ON THE IONIZATION OF ATOMS DUE TO BETA-DECAY. Feinberg, E. L. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 1: 612-20(Apr. 1965). (In Russian)

It is shown, in connection with experiments performed in recent years, which gave results in distinct contradiction with the usual theoretical formulas, that it is not possible to use formulas, taking only the shaking off effect into account, in the conditions of such experiments. Actually the direct collision of the $\beta$-electron with atomic shell electrons plays an important, and in many cases predominant, role. The corresponding formulas, which have been obtained previously are improved, extended to cases, corresponding to the new experimental conditions, and compared with the experimental results. It is shown that these results obtain a natural qualitative and in many cases also a quantitative explanation. However in some experiments the contradiction with the theory persists. (auth)

**33380** THE ANGULAR DISTRIBUTION OF THE RESONANCE SCATTERING OF 23.8-Kev QUANTA ON $Sn^{119}$ NUCLEI. Komissarova, V. A.; Sorokin, A. A.; Shpinel, V. S. (Moscow State Univ.). Yadern. Fiz., 1: 621-4(Apr. 1965). (In Russian)

The angular distributions of the resonance scattering of 23.8 kev $\gamma$-rays on $^{119}Sn$ nuclei, bound in the lattices of the compounds $Mg_2Sn$ and $SnO_2$ were measured and found equal to $W(\theta) = 1 + (0.26 \pm 0.03)P_2(\cos\theta)$ and $W(\theta) = 1 + (0.123 \pm 0.012)P_2(\cos\theta)$, respectively. The curve for $Mg_2Sn$ corresponds to a nonperturbed correlation; for $SnO_2$—to a correlation perturbed by the quadrupole interaction, where the relative magnitude of this interaction is $E_Q/\Gamma = (1.4 \pm 0.4)$. This is in agreement with data in the literature, obtained from resonance absorption spectra. (auth)

**33381** KNOCKOUT OF ALPHA-PARTICLES FROM $Be^9$ NUCLEI BY 660-Mev PROTONS. Zhdanov, A. P.; Kuz'min, V. N.; Yakovlev, R. M. Yadern. Fiz., 1: 625-8 (Apr. 1965). (In Russian)

Experimental evidence for the existence of $\alpha$-clusters inside $^9Be$ nuclei is presented. The cross-sections obtained for knock-out of $\alpha$-particle associations are compared with the calculations using shell model. (auth)

**33382** ELASTIC SCATTERING OF $He^3$ IONS ON $Be^9$, $N^{14}$ AND $O^{16}$. Artemov, K. P.; Goldberg, V. Z.; Islamov, B. I.; Rudakov, V. P.; Serikov, I. N. Yadern. Fiz., 1: 629-32(Apr. 1965). (In Russian)

The differential cross sections for the elastic scattering of $^3He$ ions on $^9Be$, $^{14}N$, and $^{16}O$ were measured at 16.6 to 36.6 Mev for angles of 15 to 90° c.m.s. The data are analyzed using the optical model with the Saxon-Woods potential. The calculations are in reasonable agreement with the experiments only for the $^9Be$ nucleus. (auth)

**33383** MASS AND KINETIC ENERGY DISTRIBUTIONS OF FISSION FRAGMENTS IN $Th^{232}$ FISSION WITH 12 Mev DEUTERONS. Nemilov, Yu. A.; Pavlov, V. V.; Selitzkii, Yu. A.; Solovev, S. M.; Eismont, V. P. Yadern. Fiz., 1: 633-8(Apr. 1965). (In Russian)

Kinetic energies of both fission fragments emitted in one fission event were measured using semiconductor detectors. The abundance surface of fragments with given mass and energy values was obtained. Special features of this surface are considered using the model of two types of fission. The connection of this model with the model of nuclear shells in fission fragments is noted. (auth)

**33384** NEUTRON EMISSION FROM $U^{233}$, $U^{235}$, $Pu^{239}$ FISSION FRAGMENTS. Apalin, V.; Gritsyuk, Yu.; Kutikov, I.; Lebedev, V.; Mikaelyan, L. Yadern. Fiz., 1: 639-46(Apr. 1965). (In Russian)

Quantitative data on neutron emission in the region of symmetrical fission were obtained. The number of false events detected in this region was decreased to 15 to 20%. (auth)

**33385** THE $N^{14}(\pi,2p)\,3\alpha$ REACTION WITH 80 Mev $\pi^+$-MESONS. Afanasev, B. P.; Ostroumov, V. I. Yadern. Fiz., 1: 647-51(Apr. 1965). (In Russian)

The reaction $^{14}N(\pi,2p)3\alpha$ was investigated for 80 Mev $\pi^+$-mesons using the nuclear emulsion method. The effective cross section is found to be equal to 27.4 ± 7.2 mb. It follows from the proton angular and energy distributions that the mechanism of the meson absorption is quasideuteron and is realized mostly on p-shell nucleons. Possible energy states of three and two $\alpha$-particles are investigated. The probability of the excitation of the $^{12}C$ nucleus to the energy 13 Mev is found to be quite considerable. (auth)

**33386** DESINTEGRATION OF PHOTOEMULSION NUCLEI BY SLOW $\mu$-MESONS. Weissenberg, A. O.; Kolganova, E. D.; Rabin, N. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 1: 652-8 (Apr. 1965). (In Russian)

The desintegration of photoemulsion nuclei due to the capture of slow $\mu^-$-mesons was investigated. The distribution of the stars with respect to the number of rays was obtained for light (C, N, O) and heavy (Ag, Br) nuclei. The probabilities of emitting a charged particle were estimated and proved to be equal to $W_L = 0.15$ and $W_H = 0.030$ for light and heavy nuclei respectively. Measurements of the secondary particle masses showed, that the output of deuterons and tritium nuclei with energies in the region 5 to 25 Mev, is approximately equal to 50% of all charged particles for light nuclei and is not larger than 15% for the Ag and Br nuclei. (auth)

**33387** PARTIAL TRANSITIONS IN THE PHOTOPRODUCTION OF CHARGED $\pi$-MESONS ON LIGHT NUCLEI. Balashov, V. V.; Korenman, G. Ya.; Macharadze, T. S. (Moscow State Univ.). Yadern. Fiz., 1: 668-75(Apr. 1965). (In Russian)

General problems of the theory of partial transitions in

the photoproduction of charged π-mesons on light nuclei are studied within the framework of the impulse approximation. A classification of the transitions is given and a number of specific reactions considered. The possibility of determining the amplitude for photoproduction on a neutron is discussed. (auth)

**33388** NEW $^{95}$Ru AND $^{101}$Ru ISOMERS. Chikhladze, V. L. Yadern. Fiz., 1: 729-30(Apr. 1965). (In Russian)

The reactions $^{92}$Mo(α,n)$^{95}$Ru, $^{98}$Mo(α,n)$^{101}$Ru, and $^{98}$Mo(α, 2n)$^{100}$Ru were carried out on enriched targets, and conversion electron spectra were measured using a double-lens beta spectrometer. Energies of the intense electron conversion lines of the products, associated gamma-transition energies, and half lives are presented. K and L conversion lines are identified. Multipolarities and spin-parity of energy levels of $^{95}$Ru and $^{101}$Ru are derived. (M.J.T.)

**33389** MEASUREMENT OF THE ANISOTROPIC SLOWING OF CHROMIUM ATOMS IN THE ENERGY REGION 20 TO 90 ev IN A VANADIUM SINGLE CRYSTAL WITH THE NUCLEAR RESONANCE METHOD. Jaehnig, F.; Kalus, J. (Technische Hochschule, Munich). Z. Naturforsch., 20a: 387-90(Mar. 1965). (In German)

It was experimentally confirmed for cubic body-centered V single crystals that the nuclear resonance fluorescence yield depends upon the orientation of the crystal. This is possible only when the slowdown of Cr recoil nuclei with energies of 20 to 90 ev in the single crystal is anisotropic. Yield differences of 10% were detected. Since the measurements permit only integral expressions over all slowdown processes within a cone of 120° angle of aperture, it must be assumed that the slowdown depends very strongly on the original flight direction of the nucleus. A formula is derived for the nuclear resonance fluorescence in single crystals with consideration of anisotropic slowdown of the nucleus. (tr-auth)

**33390** MAGNETIC MOMENT OF THE 0.57-Mev LEVEL OF $^{207}$Pb. Heuser, H. (Universitat, Giessen, Ger.). Z. Naturforsch., 20a: 490-1(Mar. 1965). (In German)

The magnetic moment of the 0.57-Mev level of $^{207}$Pb was measured from the displacement of the angular correlation of the 1.06-0.57 Mev cascade. The experimental arrangement is described, and a new measurement of the half life gave $T_{\frac{1}{2}} = 1.13 \pm 0.07 \times 10^{-10}$ sec. The magnetic moment was determined as $\mu = +1.10 \pm 0.72\ \mu_k$. (J.S.R.)

**33391** RESONANCE SCATTERING OF GAMMA-QUANTA ON $Mg^{24}$ NUCLEI. Kaipov, D. K.; Shubnyi, Yu. K.; Amerbaev, V. M.; Kazangapov, A.; Kosyak, Yu. G. (Inst. of Nuclear Physics, Kazkh SSR). Zh. Eksperim. i Teor. Fiz., 48: 1221-3(May 1965). (In Russian)

The resonance scattering on $^{24}$Mg of 1.38-Mev gamma quanta from $^{24}$Na in an aqueous solution of NaOH was investigated. The mean resonance scattering cross section was found to be $3.7 \pm 0.6 \times 10^{-28}$ cm$^2$. The energy distribution of the emitted gamma quanta is calculated for the $\beta$-$\gamma_2$-$\gamma_1$-cascade by taking into account the slowing down of the recoil nuclei. The lifetime of the 1.38-Mev level in $^{24}$Mg is found to be $1.1 \pm 0.2 \times 10^{-12}$ sec. (auth)

**33392** A STUDY OF PION CAPTURE BY $He^3$. I. CHARGE EXCHANGE AND RADIATIVE CAPTURE. Zaimidoroga, O. A.; Kulyukin, M. M.; Sulyaev, R. M.; Falomkin, I. V.; Filippov, A. I.; Tsupko-Sitnikov, V. M.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 48: 1267-78(May 1965). (In Russian)

A high-pressure diffusion chamber in a magnetic field was used to measure the ratio of the probabilities for charge exchange and radiative capture of pions by $He^3$ (Panofsky ratio). The ratio was found to be $2.28 \pm 0.18$. The magnitude of the nuclear form-factor was estimated on basis of this ratio and was found to be $F^2 = 0.75 \pm 0.06$ (transferred momentum $q^2 = 0.47$ fm$^{-2}$). The relative probabilities of charge exchange and radiative capture are $W(H^3\pi^0) = (15.8 \pm 0.8)\%$ and $W(H^3\gamma) = 6.9 \pm 0.5\%$. (auth)

**33393** INTERNAL CONVERSION COEFFICIENTS ON THE ATOMIC M-SHELL. Borisoglebskii, L. A. (Belorussian State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 1347-51 (May 1965). (In Russian)

Numerical values are presented for the internal conversion coefficients on $M_I$, $M_{II}$ and $M_{III}$ atomic subshells for M1, M2, E1 and E2 nuclear transitions. They are obtained by numerical integration of the Dirac differential equation set by taking into account the effect of the finite size of the nuclei and screening by the Thomas–Fermi–Dirac (Z = 81) and Hartree (Z = 80) methods. (auth)

**33394** SOME NEUTRON INDUCED NUCLEAR REACTIONS WITH Br, Rb, AND K USING AN ELECTROSTATIC GENERATOR REDESIGNED FOR HIGH PRESSURE OPERATION. Koenig, V. Thesis, Hamburg, Universitat, 1964. 74p. (In German). $2.00(Gmelin, AED-DISS. 64-322).

Reconstruction of an electrostatic generator to permit high pressure operation including design of an accelerator column is described. Maximum voltage is 1.8 Mv and stable operation is possible up to 1.4 Mv. Results of measurements of cross sections and secondary particle spectra of (n,α) and (n,p) reactions with Br, Rb, and K are given. (Gmelin Inst.)

**33395** THE L/K CAPTURE RATIO OF $^{51}$Cr. Heuer, W. Thesis, Muenster, Ger., Universitat, 1963. 51p. (In German). $2.00(Gmelin, AED-DISS. 63-750).

L/K capture ratios of both $^{51}$Cr transitions were determined using a coincidence method. The ratio for both transitions is $0.103 \pm 0.003$ and the value for the transition to the excited level $0.104 \pm 0.002$. These results are in agreement with theoretical data based on Bahcall's theory, which includes the influence of all electrons on capture probability. (Gmelin Inst.)

**33396** THE COUPLING OF A NUCLEON TO AN AXIAL SYMMETRIC CORE WITH ROTATION-VIBRATION INTERACTION FOR DEFORMED ODD-EVEN NUCLEI. Faessler, A. Thesis, Freiburg i. B., Universitat, 1963. 44p. (In German). $2.00(Gmelin, AED-DISS. 63-751).

A model for deformed odd-even nuclei is described. The hamiltonian consists of two parts, a rotation and vibration part for the core and an oscillator part for the single particle. Results of calculations indicate 2 γ bands, which were verified by experiments recently. Calculations based on data for $^{153}$Eu, $^{161}$Dy, and $^{185}$Re, using the deformed nuclear model are in better agreement with experimental results than results based on the adiabatic model. (Gmelin Inst.)

**33397** THE ATOMIC NUCLEUS. Korsunsky, M. Russian Monographs and Texts on Advanced Mathematics and Physics. Volume XIX. Translated from the Russian by G. Yankovsky. New York, Gordon and Breach Science Publishers, 1965. 455p.

Fourteen chapters are included, which deal with radioactivity, the nuclear model of the atom, the mass of atomic nuclei, the disintegration of atomic nuclei, the discovery of the positron, the artificial transformation of atomic nuclei, artificial radioactivity, mesons, the neutrino, the structure of atomic nuclei and the forces acting between nuclear particles, nuclear fission, nuclear chain reactions, the peaceful uses of atomic energy, and thermonuclear reactions. Illustrations are given in the appendix. (L.B.S.)

**33398** STUDIES OF THE BETA DECAY OF $^{235}$U FISSION PRODUCTS. Armbruster, P. Thesis, Munich, Technische Hochschule, 1964. 46p. (In German). $2.00(Gmelin, AED-DISS. 64-465).

Methods and results of fission product studies are reviewed. Methods for the measurement of the average primary fission product charge are discussed. Experimental results obtained by 3 different methods are compared with radiochemical and theoretical data. New methods for the analysis of single nuclides are discussed. Experimental data characterizing asymmetric fission are compiled. A new model for the nucleus undergoing fission is developed. (auth)

# Plasma Physics and Thermonuclear Processes

*Refer also to abstracts 32853, 33084, and 33153.*

**33399** (AD-607999) MAGNETOHYDRODYNAMIC VORTICES. Lewellen, W. S. (Space Technology Labs., Inc., Los Angeles, Calif. Propulsion Lab.). May 31, 1960. 37p. (STL/TR-60-0000-09147). $2.00(CFSTI).

A magnetohydrodynamic body force is considered in interaction with a two-dimensional vortex in a viscous, conducting fluid. The equations governing the motion are presented and briefly discussed. Applied magnetic and electric fields are chosen in accordance with Maxwell's equations and in such a way as to yield a tangential body force. It is shown that whenever the magnetic Reynolds number based on the radial velocity component is much less than one, the tangential body force due to the induced magnetic field can be neglected in comparison with that due to the applied. For these conditions the problem reduces to that of solving a second-order, linear differential equation for the tangential velocity. Analytic solutions are found for different cases. The fundamental dimensionless parameters in each case are the Hartmann number, the Reynolds number based on the radial mass flow, and the ratio of the applied to the induced electric field. The results are plotted for reasonable values of these parameters. The effect of the applied magnetic and electric fields on the temperature and pressure distributions in a steady, axisymmetric, compressible vortex is presented. (auth)

**33400** (AD-608379) RESEARCH IN HIGH-TEMPERATURE PLASMAS FOR SPACE APPLICATIONS. VOLUME I. PHYSICS. (Aerojet-General Nucleonics, San Ramon, Calif.). Oct. 1964. Contract AF33(657)-11183. 196p. (APL-TDR-64-124(Vol.I)). $5.00(CFSTI).

Theoretical studies show that adiabatic minimum-B geometries are flute stable at high beta. Magnetic field requirements to achieve a quadrupole adiabatic minimum-B mirror-cusp system are discussed. Theoretical and experimental investigations of the dissociative and excitative processes in energetic arcs are reported. Data of this high neutral yield and the yield of excited neutrals from an arc converter are presented including diagnostic and spectroscopic analysis. System studies include various methods of injecting and trapping excited and nonexcited H(o) and H2 (+) and the trapped particle density required for burnout. A preliminary study of momentum and energy exchange in the exhaust beam from a mirror-cusp system is presented. (auth)

**33401** (AD-611202) SELF AND MUTUAL ADMITTANCES OF WAVEGUIDES RADIATING INTO PLASMA LAYERS. Scientific Report No. 5. Galejs, J. (Sylvania Electronic Systems, Waltham, Mass. Applied Research Lab.). Sept. 1, 1964. Contract AF19(628)-2410. 39p. (AFCRL-64-1000). $2.00(CFSTI).

The self and mutual admittance of waveguide backed slots radiating into a plasma (or dielectric) layer is formulated in a laterally unbounded geometry. The admittance expression involves integrals that may be approximated by summations for numerical calculations. For a constant mesh size approximation to the integrals the summations are the same as obtained in earlier work, where the plasma layers are considered to be within a wide waveguide. The accuracy of the solution is improved by decreasing the mesh size used for the numerical integration, which is equivalent to increasing the size of the large guide in the waveguide model. Mutual admittance calculations between two parallel slots show that the presence of a plasma layer decreases the mutual admittance relative to its free space value. (auth)

**33402** (AFCRL-65-315) RESEARCH DIRECTED TOWARD PLASMA STABILITY STUDIES IN MAGNETIC FIELDS. Final Report, March 1963–March 1965. Besse, Arthur L.; Prasad, Balram; Bakshi, Pradip; Golden, Kenneth I.; Nichols, Ivan A. (Williamson Development Co., Inc., West Concord, Mass.). Mar. 15, 1965. Contract AF19(628)-2843. 90p. CFSTI.

Preliminary x-ray studies of high density plasmas produced by exploding wires are described. Symptoms of turbulence, which are always observable in light-picture studies, were not detected in the x-ray photographs. Further investigations are suggested wherein dual x-ray equipment might be used together with more accurate scanning techniques. An interferometer with laser source as a means of determining electron densities is discussed and an electron beam instrument for determining heavy particle densities is described. Physical characteristics and implications of the moving radiation sources observed in shock tube experiments are considered. The electrical conductivity of a partially ionized gas in a uniform magnetic field is determined. This extension of the Sen-Wyller magnetoionic theory was motivated by the fact that ionospheric, interstellar, and laboratory plasmas do contain neutral gas molecules. A nonlinear analysis of plasma oscillations reveals the existence of composite modes resulting from the repeated mutual interaction of the incident field and plasma components and an infinity squared of Larmor resonances. A conjectural study of small amplitude wave motions in a two-stream hydromagnetic gas with Hall perturbations is made. (auth)

**33403** (IPP-6/35) EINSCHLIESSUNG EINES PLASMAS IM DYNAMISCHEN GLEICHGEWICHT IM TOROIDALEN Z-PINCH. (Confinement of a Plasma in Dynamic Equilibrium in a Toroidal z-Pinch). Badr, Omar (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1965. 54p. Dep.(mn).

The confinement of a plasma in a toroidal z-pinch is investigated. The plasma is described in terms of hydromagnetic equations, infinite conductivity being assumed and consideration limited to rotational symmetric steady-state solutions (dynamic equilibrium). Of particular significance is the case where $\nabla \cdot \underline{u} \neq 0$ everywhere. It is shown that the toroidal component $u\varphi$ of the velocity is then everywhere equal to zero and solutions are obtained in the form of power series in accordance with the reciprocal aspect ratio of the torus. Numerical results are indicated for the zeroth and first orders. It is found that in the case of high pressure on certain discrete areas of the plasma nearly all physical quantities are constant, the velocity being equal to zero. Furthermore, the case $\nabla \cdot \underline{u} \equiv 0$ is considered. Here steady-state solutions are found, but these violate the confinement condition. (auth)

**33404** (LA-3320) SEMIANNUAL STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR PERIOD ENDING APRIL 30, 1965. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). May 1965. Contract W-7405-eng-36. 108p. Dep.; $4.00(cy), 2(mn) CFSTI.

Nineteen papers are included; separate abstracts have been prepared for all. (T.F.H.)

*For abstracts of individual papers see: 32410, 32411, 32854, 33405, 33406, 33407, 33408, 33409, 33410, 33411, 33412, 33413, 33414, 33415, 33416, 33417, 33418, 33419, and 33420.*

**33405** (LA-3320(p.6-13)) COMPUTATION OF PULSED MAGNETIC AND ELECTROSTATIC FIELDS IN CAULKED CUSPS. Lewis, H. R. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Pulsed magnetic and electrostatic fields in axisymmetric caulked and stuffed cusps are calculated, taking into account eddy currents produced by magnetic field exclusion from the metallic walls of the cusp chamber. A differential equation for the fields is found, and a method is devised for solving the differential equation in sums of polynomials. Sample magnetic-field calculations are shown graphically. (T.F.H.)

**33406** (LA-3320(p.14-18)) NONZERO MINIMUM B EXPERIMENT—CAULKED, STUFFED CUSP GEOMETRY. Burkhardt, L. C.; DiMarco, J. N.; Karr, H. J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Measurements are reported of E X B plasma heating

in mirror geometry and of magnetic fields in caulked, stuffed cusps. (T.F.H.)

**33407** (LA-3320(p.19-23)) DENSE PLASMA FOCUS EXPERIMENT. Mather, J. W.; Williams, A. H.; Wittman, F. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Schlieren photography of a dense electron plasma is described. The use of this photography to determine the plasma size and refractive index is detailed. Neutron production mechanisms in this plasma are investigated by immersing D(Zr) and T(Zr) targets in the plasma. (T.F.H.)

**33408** (LA-3320(p.27-9)) "SLINGSHOT" ACCELERATOR. Mather, J. W.; Wittman, F. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The plasma accelerator described consists of two concentric drive coils, which produce a quadrupole magnetic field in the annular region formed by the two drive coils and a third concentric coil located at the end of the two drive coils. The third coil generates a magnetic field that unbalances the axial field, and thus produces an axial thrust on the plasma formed between the drive coils. (T.F.H.)

**33409** (LA-3320(p.33-4)) TOROIDAL CAULKED CUSP DESIGN. Marshall, J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The feasibility of thermonuclear reactors utilizing toroidal caulked cusp fields is discussed. (T.F.H.)

**33410** (LA-3320(p.35-44)) CAULKED CUSP DESIGN CALCULATIONS. Baker, D.; Mann, L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Investigations are reported of the quadrifilar caulked cusp field geometry, aimed at the design of a closed, stable confining magnetic field that is capable of containing 10-kev ions injected coaxially. Computer analyses of the field geometry are scaled appropriately to meet design criteria. Limitations on the device, arising from maximum field strengths and finite electric conductivities, are discussed. (T.F.H.)

**33411** (LA-3320(p.45-9)) INDUCTIVE ENERGY STORAGE. Henins, I.; Marshall, J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The energy-storage and switching problems associated with inductive and inductive-capacitive energy storage systems for plasma machines are outlined. (T.F.H.)

**33412** (LA-3320(p.51-61)) HYDROMAGNETIC PLASMA GUN PROGRAM. Henins, I.; Marshall, J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

An axial magnetic bias field is added to the barrel of a hydromagnetic plasma gun, in order to make gun operation more reliable and reproducible. The mass-to-charge ratios of the plasma ions produced by the gun are analyzed by a magnetic analyzer. The plasma is also analyzed by framing cameras, current and potential probes, laser interferometers, and magnetic probes. (T.F.H.)

**33413** (LA-3320(p.62-6)) FRAMING CAMERA PICTURES OF PLASMA GUN DISCHARGE. Henins, I.; Kewish, R.; Marshall, J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The plasma from a hydromagnetic plasma gun is photographed using a framing camera, by two methods: in one, the camera is aimed directly into the gun muzzle; in the other, photographs are taken of the luminescence of Pyrex glass plates placed in the path of the plasma. (T.F.H.)

**33414** (LA-3320(p.71-6)) TRANSVERSE INJECTION. Baker, D. A.; Hammel, J. E.; Smith, W. B. C. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Measurements are made of the energy density, electron density, plasma density, and electric fields in plasma streams moving in transverse magnetic fields. It is concluded that the stream remains collimated during the field traversal; that the stream is stopped at the field null of the transverse field; and that complicated motions occur within the plasma during the traversal of the field. (T.F.H.)

**33415** (LA-3320(p.78-82)) SCYLLA IV OPERATION. Little, E. M.; Quinn, W. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Scylla IV operations, maintenance, and modifications are reviewed. (T.F.H.)

**33416** (LA-3320(p.83-7)) ELECTRON DENSITY PRODUCED BY THE PREIONIZER IN SCYLLA IV. Little, E. M.; Quinn, W. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Preionized plasma densities in Scylla IV are measured as functions of the initial $D_2$ filling pressure and bias magnetic field. A laser beam is sent down the axis of the compression coil and reflected from a mirror at the opposite end of the coil back through the plasma into the laser. The phase modulation of the returning i-r radiation, which is a function of optical path length (and therefore of plasma density), modulates the intensity of i-r light emitted by the laser. This intensity modulation is used as an indicator of plasma density. Tabular and graphic experimental results are presented. (T.F.H.)

**33417** (LA-3320(p.88-90)) A TOROIDAL CONFINEMENT SYSTEM FOR Θ-PINCH PLASMAS WITH INTERCHANGE STABILIZATION. Ribe, F. L.; Riesenfeld, W. B. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Longitudinal electric conductors are placed inside a toroidal theta-pinch chamber in order to stabilize the plasma formed therein. The longitudinal conductors produce transverse multipole magnetic fields which, in combination with the main compression field, yield a field minimum near the center of the pinch chamber. This minimum produces gross plasma stability. (T.F.H.)

**33418** (LA-3320(p.91-5)) SCATTERING MEASUREMENT OF ION ENERGIES IN THETA PINCHES. Ribe, F. L.; Sawyer, G. A.; Thomas, K. S.; Borkenhagen, W. H.; Rawcliffe, A. S. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The ion energy distributions in theta-pinch plasma are measured by means of Thomson scattering of ruby-laser light by plasma electrons, in the region of electron Debye length for which cooperative effects between electrons are predominant. In this region, the Doppler broadening of the scattered spectral line is a measure of the ion energy. (T.F.H.)

**33419** (LA-3320(p.96-7)) PROPOSAL FOR A CLOSED TOROIDAL THETA PINCH (SCYLLAC). Quinn, W. E.; Ribe, F. L.; Sawyer, G. A.; Kemp, E. L.; Tuck, J. L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The Scyllac concept comprises a toroidal device of about 4 m major diameter and 12.5 cm bore. The device permits studies of stable confinement in toroidal geometries in regimes unexplored in theta pinches. Confinement times on the order of 100 μsec are expected. The magnets will produce fields of about 120 kOe, and the device will use about 30 MJ energy storage. (T.F.H.)

**33420** (LA-3320(p.104-7)) EQUIPMENT DEVELOPMENT AND TESTING. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The development of capacitors, switches, and a 10-kv energy storage system is described. Various coaxial cables are evaluated. (T.F.H.)

**33421** (MPI-PA-16/64) PARTICLE LOSSES OF AN ALKALI PLASMA CONFINED RADIALLY BY A STRONG MAGNETIC FIELD AND AXIALLY BY ELECTRON EMITTING ENDPLATES. Grieger, Guenter (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Sept. 1964. 38p. Dep.(mn).

The particle loss mechanism is investigated for a low density alkali plasma in a Q-machine assuming an electron sheath to be present on the end plates. It is shown that the existence of classical diffusion and volume recombination leads to a significant deviation from the equilibrium model, because losses due to resistive diffusion and volume recombination are proportional to $n^2$ and the energy distribution of the lost particles agrees with the complete distribution function. The replacing particles belong to the

high energy tail of the distribution function since they have been accelerated by the sheath voltage, and diffusion of particles in velocity space is necessary to restore the distribution function steadily. This flux of diffusing particles is proportional to the collision frequency, $\nu_{ii}$, — which in turn is proportional to n —and to the input flux of ions. Therefore, the input flux of ions is proportional to n to compensate the ion loss flux from the plasma volume, i.e., the high energy tail of the distribution function is overpopulated (~1/n) compared to the equilibrium model to achieve a steady state situation. But it is just the high energy tail of the distribution function which is in an intensive interaction with the endplates and which thus experiences large losses due to end plate recombination and end plate diffusion. Thus $\phi_0$ becomes proportional to n instead of $n^2$. This picture is valid only for $\lambda_s > 2L_0$ because only in this case is the plasma no longer collision dominated and a considerable fraction of the ions starting at one plate can reach the second one. An experiment was started to investigate whether additional losses appear if the magnetic field becomes curved. The magnitude of the additional loss rate can be estimated from experiments in toroidal geometry and can be described by the Bohm diffusion coefficient. Consequently, the measurement should be carried out in the low density region. But it is shown that in the presence of probes the mean particle lifetime of the ions is already as short as expected if Bohm diffusion sets in. It is also shown that in the absence of probes the mean ion lifetime is increased only by about one order of magnitude independently on the particle density. Thus, additional losses of this type should be detectable, but they might be difficult to separate from various other effects. (auth)

**33422** (NYO-2813-30) PROPERTIES OF ALKALI-METAL MAGNETOPLASMAS RELATED TO ENHANCED DIFFUSION. Wolf, N.; Rogers, K.C. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). [1964]. Contract AT(30-1)-2813. 9p. (CONF-640621-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium on Diffusion of Plasma Across a Magnetic Field, Feldafing/Starnberger See, Ger.

Studies on thermal cesium and potassium plasmas in a magnetic field gave evidence for the presence of unexpected high particle losses in these plasmas. The observed losses may be related to those reported earlier by Bonnal et al. in a PIG discharge, where no directed axial current was present either. The results suggest that the anomalies are associated with transverse electron currents near the ends of the plasma column. (auth)

**33423** (ORNL-P-153) SIMPLE MOMENTUM PROBE FOR PLASMA STUDIES. Alexeff, I.; Jones, W. D. (Oak Ridge National Lab., Tenn.). [1961]. Contract W-7405-eng-26. 7p. Dep.(mn); $1.00(cy), 2(mn) CFSTI.

A bare-wire plasma probe is described, at whose end is a magnetic-field-producing loop. The probe is capable of carrying a peak current of 425 A for 1 sec without excessive heating. The peak magnetic field produced by this current is about 50 Oe. The probe is used for momentum-distribution measurements in plasma. (T.F.H.)

**33424** (R65SD13) RADIATION EMITTED FROM A HIGH-TEMPERATURE NONEQUILIBRIUM NITROGEN PLASMA. Kulander, John L. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). June 1965. 50p.

The spectral distribution of radiation emitted from a uniform plane-parallel layer of low density nitrogen plasma is obtained for various layer thicknesses. Electron densities from $10^{13}$ to $10^{19}/cm^3$ and electron temperatures between $10^4$ and $10^{6}$°K are assumed. The system is not in a state of local thermodynamic equilibrium because at the low densities considered the transition rates are not collision dominated nor is the gas optically thick. Electrons contributed from sources other than nitrogen are possible although no sources of radiation other than nitrogen are assumed. The plasma is irradiated by an external diluted Planckian field $WB_\nu(T_r)$. The occupation numbers of the various energy levels are obtained through simultaneous solution of the population rate equations and the Eddington transfer equation. (auth)

**33425** (SIT-P144) FLOW OF PLASMA AROUND A MAGNETIC DIPOLE. Scientific Report No. 1. Bostick, W. H.; Byfield, H.; Casale, P.; DiMarco, J. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Mar. 1965. Contract AF19(628)-2398. 22p. (AFRCL-65-293). CFSTI.

Image converter photographs of plasma flow over a magnetic dipole field exhibit general boundary shapes which are in accord with the theoretical shapes computed on the basis of specular reflection of the ions at the boundary of the magnetic cavity. Magnetic probe measurements show that the magnetic field is highly turbulent in the magnetic boundary and correlation measurements show that this turbulence is not a breathing of the boundary as a whole, but a corniness in the direction perpendicular to the magnetic field and the initial plasma flow. Electric-field probe and ion density probe measurements also show that plasma is turbulent in the boundary of the magnetic cavity, and that the plasma penetrates the cavity in a turbulent state. The character of the signals suggests that the turbulence is in the form of plasma eddies or vortices. (auth)

**33426** (SU-IPR-7) STUDIES OF PLASMA OSCILLATIONS. Quarterly Status Report No. 21, December 1, 1964–February 28, 1965. (Stanford Univ., Calif. Inst. for Plasma Research). Mar. 1965. Contract AT(04-3)-326. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Oscillations and instabilities of d-c-discharge plasma in magnetic fields are investigated. Particular studies reported include: ion-wave propagation and positive-column instabilities; electron-beam probing of plasma; beam-plasma interactions; and positive-column resonances and propagation. (T.F.H.)

**33427** EXPERIMENTS WITH A COAXIAL HALL CURRENT PLASMA ACCELERATOR. Grossman, William Jr. (Langley Research Center, Hampton, Va.); Hess, Robert V., Hassan, H. A. AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1034-9(June 1965).

Experiments with a Hall current accelerator using coaxial electrodes and externally applied diverging magnetic fields are reported. The accelerator is operated with mass flows of 0.0164 and 0.0338 g/sec, currents from 300 to 600 amp, and magnetic fields from 1000 to 6000 gauss. The measured values of thrust, specific impulse, power input, and efficiency show an approximately linear increase with increasing magnetic field. The experiments were performed mostly with argon; however, in a few tests, nitrogen and helium were used. The thrusts for the various gases are about the same for given mass flows. However, for argon, and to a lesser degree nitrogen, anomalously high specific impulse is obtained. Possible mechanisms for attaining these results are given. The influence of conditions in the vacuum chamber on operation of the device is, however, also investigated to determine if these desirable results are genuine or based on improper simulation of the space environment. (auth)

**33428** RESEARCH ON A LINEAR DIRECT-CURRENT PLASMA ACCELERATOR. Carter, A. F.; Wood, G. P.; McFarland, D. R.; Weaver, W. R. (Langley Research Center, Hampton, Va.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1040-5(June 1965).

Some results from a continuing research program on linear d.c. plasma accelerators are reported for an accelerator that has a channel 1 in. square and 12 in. long. This accelerator uses nitrogen seeded with 0.3% mole fraction cesium and operates at relatively high pressure, 50 mm Hg, and high magnetic field, 11,500 gauss. Power input to the accelerator is about 360 kw, with about 50 amp through each of 24 electrode pairs. The 1200-v axial potential difference, which is self-generated in the plasma between the ends of the accelerator, has posed operational problems, since this high voltage tends to find closed circuits to ground and back through paths external to the channel. Steps taken to alleviate these problems are described. Experience with the problem of erosion is described. A method for making time-of-flight velocity

measurements, with an injected spark and an image-converter framing camera, has been developed. These measurements show an entrance velocity of 2000 m/sec and exit velocities of 6000–6850 m/sec. This tripling of the velocity by the accelerator is the best performance reported for an accelerator at rather high gas density, in this case $1.7 \times 10^{-3}$ kg/m$^3$ at the exit. (auth)

**33429** ENERGY LOSS IN PULSED COAXIAL PLASMA GUNS. Ashby, D. E. T. F. (General Dynamics/Convair, San Diego, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1045-7(June 1965).

The one-dimensional flow of a current-carrying plasma, driven into neutral gas by its self-magnetic field, is considered for the case where both the neutral gas and the current have arbitrary distributions in the direction of flow. The conservation laws are used to derive a simple expression for the amount of input power that goes into all forms of internal energy. It is shown that this power depends mainly on the rate at which the current sheet sweeps up neutral gas. In principle, internal energy can be converted into directed energy by expansion; however, it is argued that, in the coaxial plasma accelerators currently used in propulsion studies, most of the internal energy will be lost by excitation and subsequent radiation or ionization before expansion occurs. (auth)

**33430** EXHAUST MEASUREMENTS ON THE PLASMA FROM A PULSED COAXIAL GUN. Ashby, D. E. T. F.; Gooding, T. J.; Hayworth, B. R.; Larson, A. V. (General Dynamics/Astronautics, San Diego, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1140-2(June 1965).

A probe for measuring ion current is described with which ion densities up to $3 \times 10^{13}$ cm$^{-3}$ and ion velocities from $10^6$ to $10^7$ cm-sec$^{-1}$ were determined as a function of time and position in a nitrogen plasma from a coaxial gun. The simplicity and compact size of the ion probe, with or without an analyzing grid, makes it ideal for probing the exhaust plasmas from pulsed plasma guns. (W.L.G.)

**33431** SWITCH-TRIGGERED PULSED PLASMA ACCELERATOR THRUST MEASUREMENTS. Guman, William J. (Republic Aviation Corp., Farmingdale, N. Y.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1158-9(June 1965).

A low-pressure, linear pinch-type switch was devised and inserted in series into the electrical circuit of a pinch-type pulsed plasma accelerator to initiate the electrical discharge. The specific thrust of the accelerator could be raised by as much as 30% by imposing delays as long as 1500 μsec beyond the time when a discharge would have occurred had the discharge been initiated by the propellant-triggering method. (W.L.G.)

**33432** MAGNETOHYDRODYNAMIC EFFECT ON OPEN-CHANNEL FLOW. Bornhorst, Walter J. (Massachusetts Inst. of Tech., Cambridge). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1180-1(June 1965).

The behavior of a conducting fluid flowing in the absence of an electric field in an open channel under the influence of gravity and an applied vertical magnetic field, was investigated theoretically and experimentally. A good agreement was obtained between the experimental and theoretical values of the free surface. (W.L.G.)

**33433** COMBINED FORCED AND FREE CONVECTION CHANNEL FLOWS IN MAGNETOHYDRODYNAMICS. Yu, C. P. (State Univ. of New York, Buffalo). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1184-6(June 1965).

Basic equations and their solutions dealing with the combined forced and free convection of an electrically conducting fluid flowing inside an open-ended vertical channel formed by two identical parallel plates in the presence of a uniform transverse magnetic field are presented. Solutions are obtained for the case when the surface temperatures of the plates vary linearly along the vertical distance. (W.L.G.)

**33434** MINIMUM LENGTH MHD ACCELERATOR WITH CONSTANT ENTHALPY. Mirels, Harold; Gold, Richard R.; Mullen, James F. (Aerospace Corp., El Segundo, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1191-2(June 1965).

Solutions providing a first estimate for a physically realistic minimum-length crossed-field magnetohydrodynamic accelerator are presented. It was assumed that the flow was one-dimensional, that the working fluid was a perfect gas, that the enthalpy was constant, and that the local joule heating was small as compared with the net local electrical power input. The magnetic field and electric conductivity were variable. (W.L.G.)

**33435** DYNAMIC EFFICIENCY OF PULSED PLASMA ACCELERATORS. Black, Neville A.; Jahn, Robert G. (Princeton Univ., N. J.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1209-10(June 1965).

A simple analytical argument is presented for estimating the energy division for arbitrary profiles of shock velocity along pulsed plasma accelerators. It may also be used for arbitrary one-dimensional accelerator geometries and initial gas density distributions. (W.L.G.)

**33436** STABILITY OF A ROTATING PLASMA IN TWISTED MAGNETIC FIELD. Verma, Pratibha; Verma, Y. K. (Univ. of Delhi). Ann. Astrophys., 28: 357-9(Mar.-Apr. 1965).

The hydromagnetic stability of an incompressible, rotating plasma cylinder in a twisted magnetic field was studied. The effect of gravitation of the medium was included in view of its astrophysical significance. The dispersion relation is obtained, which comes out to be a complex and implicit function of the frequency of perturbations. Numerical solutions of the dispersion equation for the zero mode were found, and the following results were obtained; rotation enhances the instability and causes it to develop as an overstability for the gravitating plasma cylinder; the axial current has a destabilizing influence on the cylinder considered. (auth)

**33437** TRANSVERSALLY MODULATED ELECTRON BEAMS IN SPATIALLY PERIODIC MAGNETIC FIELDS. Seunik, Horst (Siemens and Halske AG, Munich). Arch. Elek. Uebertrag., 18: 519-24(Sept. 1964). (In German)

The amplification ranges of the transversal modes of a pencil beam in a periodical sequence of sudden changes of the magnetic field agree with the instability ranges of the stationary electron beam with negligible space charge. The magnetic field at the cathode has no influence on the instability limits. The amplification and instability ranges, respectively, are stated for a periodical sequence of sudden changes of the magnetic field and for a sinusoidally variable magnetic field. The instability limits, as determined by experiment for low d-c field components of the sinusoidal magnetic field show that space charge in this case does not exert any essential influence on the instability limits. (auth)

**33438** GENERALIZED OHM'S LAW IN A MAGNETIC PLASMA. Szabo, J.; Abonyi, I. (Technical Univ., Miskolc, Hungary and Eotvos Lorand Univ., Budapest). Beitr. Plasmaphysik, 5: 9-12(1965).

A solution of the equation obtained for the generalized Ohm's law under the assumption of binary collision only for a two-component plasma in a constant and homogeneous magnetic field is given for the case in which the electric field is perpendicular to the magnetic field. The current densities in the case of no magnetic field and of ions infinitely heavier than the electrons are obtained as special cases. (D.C.W.)

**33439** TRANSVERSE PLASMA OSCILLATIONS EXCITED BY INTERPENETRATING BEAMS OF POSITIVELY AND NEGATIVELY CHARGED PARTICLES. Uberoi, C. (Indian Inst. of Science, Bangalore). Beitr. Plasmaphysik, 5: 95-122(1965).

The problem of the interaction of an electron beam with a moving beam of ions is considered. First, the steady-state problem is solved when the beams are bounded by two parallel planes perpendicular to their directions of motion. Then this steady state is slightly disturbed, and the subsequent propagation of this small disturbance is studied. It is found that the equations defining the transverse propa-

gation fall into a separate group. Transverse propagation only is considered, and the results are obtained correct up to the third power of the ratio of the initial electron beam velocity to the velocity of light. It is found that the dispersion relation breaks up into four separate equations, and the propagation represented by each equation is considered in detail. Under the physical conditions present in a strong hydrogen discharge, the wave velocity for the first few harmonics attains the extreme value when the wave length is approximately equal to three times the Debye distance. When the wave number is taken to be zero, the plasma oscillates as a whole with amplitudes increasing or decreasing with time. (auth)

**33440** CONTINUOUS EMISSION SPECTRUM OF AN "ARGON PLASMA BLAST JET" IN THE VISIBLE AND THE FAR INFRARED. Cabannes, Francois; Chapelle, Joseph; Sy, Alassane (C.N.R.S., Bellevue, France). Compt. Rend., 260: 3320-2(Mar. 22, 1965). (In French)

A study was made of the emission spectrum of an argon plasma blast jet in the visible ($16{,}000 < \sigma < 30{,}000$ cm$^{-1}$) and the far infrared ($300 < \sigma < 2{,}000$ cm$^{-1}$) for an electric power of 7.2 kw. From the measurements made in the far infrared, it is shown that the largest part of the visible radiation is a recombination radiation. The experimental results are compared with the formulas established for arcs by W. Finkelnburg and Th. Peters. (tr-auth)

**33441** PLANE LONGITUDINAL WAVES IN THE PRESENCE OF AN ELECTRIC FIELD IN A WEAKLY IONIZED PLASMA. Doucet, Henri; Jones, William Denver (Ecole Polytechnique, Paris and Oak Ridge National Lab., Tenn.). Compt. Rend., 260: 3577-9(Mar. 29, 1965). (In French)

The propagation of a plane pseudo-sonorous ionic wave in a weakly ionized plasma is studied by the adiabatic macroscopic theory and the effect of a continuous electric field in the presence of collisions on the neutral particles is discussed. The theory reveals the existence of two distinct modes of propagation that are amplified or damped in space according to the value of the electric field. (tr-auth)

**33442** THE VLASOV EQUATIONS OF A RELATIVISTIC PLASMA. Hakim, Remi (Faculte des Sciences, Orsay, France). Compt. Rend., 260: 3861-4(Apr. 5, 1965). (In French)

The methods of relativistic statistical mechanics reported by Hakim in Compt. rend. 260, 2997(1965) are illustrated. The case of the completely ionized plasma is considered in particular. (tr-auth)

**33443** NON-LINEAR EFFECTS IN AN ANISOTROPIC LORENTZIAN PLASMA: CALCULATION OF THE ELECTRONIC CONDUCTIVITY IN THE PRESENCE OF TWO SUPERPOSED ELECTRIC FIELDS. Basu, Diptendu; Jancel, Raymond; Kahan, Theo (Institut Henri Poincare, Paris). Compt. Rend., 260: 3877-80(Apr. 5, 1965). (In French)

The electric conductivity of an anisotropic Lorentzian plasma exposed to the action of two superposed electric fields was calculated. The existence of various non-linear effects, whose importance is closely bound to the nature of the electron-molecule interaction, is shown. (tr-auth)

**33444** SYMMETRICAL ACCELERATION AND REFLECTION OF INTENSE PLASMA JETS IN A VERY HIGH-FREQUENCY STRUCTURE. Consoli, Terenzio (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., 260: 4163-6(Apr. 12, 1965). (In French)

The principle and abbreviated theory of an apparatus permitting simultaneously the acceleration, reflection, and interaction of intense plasma jets were given. (tr-auth)

**33445** NEUTRONS PRODUCED BY AN EXPERIMENT OF FAST LINEAR PINCH. Bobin, Jean-Louis (Commissariat a l'Energie Atomique, Paris). Compt. Rend., 260: 4167-70(Apr. 12, 1965). (In French)

The discharges in deuterium produce a weak emission of neutrons whose origin is attributed to a turbulence phenomenon. (tr-auth)

**33446** BETTER CAGES FOR THERMONUCLEAR PLASMA. Engineering, 197: 877-9(June 26, 1964).

The activities and facilities of the Culham laboratory for thermonuclear research are outlined. Experiments on magnetic trap stability and plasma containment by rotating magnetic fields are briefly discussed, together with the FAUST, TIBER, and ZETA devices. Development in switching, sampling circuitry, and cryopumps are summarized, together with the use of computers by the laboratory. (D.C.W.)

**33447** STUDY OF A STEADY-STATE ARGON–CESIUM PLASMA WITH NONEQUILIBRIUM CONDUCTIVITY. Golubev, V. S.; Kasabov, G. A.; Konakh, V. F. High Temp. (USSR) (English Transl.), 2: 445-59(July-Aug. 1964). Translated from Tepolfiz. Vysokikh Temp., 2: 493-509 (July-Aug. 1964).

Using various methods, a detailed study was made of the parameters of a steady-state Ar-Cs plasma for Ar pressures of 20 to 240 mm Hg, Cs pressures $10^{-4}$ to $10^{-1}$ mm Hg, and a current density of 1 amp/cm$^2$. It is shown that a nonequilibrium plasma conductivity ($\sigma \sim 1$ mho/cm), in which the gas temperature (600 to 800°K) is far less than the electron temperature (2000 to 3000°K), can exist. It is shown that this conductivity can be calculated, starting from experimental values of the contribution of inelastic electron energy losses ($\delta \approx 1$-10) and the collision frequencies of electrons with atoms. Comparison of the Ar-Cs plasma with He-Cs, pure Ar, and pure Cs plasmas, made during analysis of the experimental results, permits the recommendation of Ar-Cs plasma as a most profitable working substance for an MHD transformer from the point of view of nonequilibrium conductivity. (auth)

**33448** REDUCTION OF THE ELECTRON-DETACHMENT POTENTIAL FOR NEGATIVE IONS IN A PLASMA. Avilova, I. V.; Norman, G. E. (Moscow Power Inst. and High Temperatures Research Inst.). High Temp. (USSR) (English Transl.), 2: 466-71(July-Aug. 1964). Translated from Tepolfiz. Vysokikh Temp., 2: 517-24(July-Aug. 1964).

A list and discussion are presented for the factors that are responsible for deviation from ideal behavior and that may affect the concentration of negative ions in a plasma. Corrections are proposed for the concentration formula; these take account of the effective reduction in the statistical weight and binding energy consequent on the microfields. It is found that these corrections can be very substantial and that there is a range of temperatures and pressures in which weakly bound negative ions can not exist. The long-wave threshold for photodetachment is also considered. The proposed theoretical expressions agree with the available experimental data. (auth)

**33449** LENGTHWISE STABILITY OF THE ONE-DIMENSIONAL FLOW OF A CONDUCTING GAS. Artyushkov, E. V.; Morozov, A. I. High Temp. (USSR) (English Transl.), 2: 472-81(July-Aug. 1964). Translated from Tepolfiz. Vysokikh Temp., 2: 525-34(July-Aug. 1964).

The short-wave longitudinal oscillations in a one-dimensional flow of a gas of finite conductivity in a magnetic field are studied. Frozen-in oscillations are considered in relation to low and high thermal conductivity. Expressions are obtained for the variation in amplitude of the wave along the flow. (auth)

**33450** LONG-TIME BEHAVIOR OF THE ELECTRIC POTENTIAL AND STABILITY IN THE LINEARIZED VLASOV THEORY. Saenz, Albert W. (Naval Research Lab., Washington, D. C.). J. Math. Phys. (N. Y.), 6: 859-75(June 1965).

It is studied in a mathematically rigorous manner how the electric potential, produced by small electronic charge density oscillations of definite wavenumber vector k in a plasma, behaves in the long-time limit and the connection between this behavior and the stability of a given steady, spatially uniform, distribution of the plasma electrons. The work is based on the linearized Vlasov equation and on the associated Poisson equation. A very general initial-value problem concerning this system of equations is formulated, writing the electric potential at a given position vector r and time t as $\varphi(t)e^{ik\cdot r}$ multiplied by a suitable constant,

where $\varphi(t)$ is independent of r. The existence and uniqueness of solution of the problem is established by exploiting the fact that, in the linear theory, $\varphi(t)$ obeys an inhomogeneous Volterra integral equation of convolution type, which is rigorously derived. A detailed study of the asymptotic properties of the solutions of this equation for $t \to \infty$ is made, including the establishment of necessary and sufficient conditions on the initial perturbations (perturbations (of the steady electron distribution function at $t = 0$) for $\varphi(t)$ to be of negative exponential order as $t \to \infty$. As a byproduct of this asymptotic investigation, a precise discussion of the Landau damping of long wavelength plasma oscillations in an initially Maxwellian plasma is given, concluding that in this case $\varphi(t)$ exhibits such damping for a broad range of initial perturbations and that the damping decrement is essentially that first computed by Landau. Criteria of stability and instability is introduced based on the boundedness and unboundedness, respectively, in the limit $t \to \infty$ of certain nonnegative quantities $W_p(t)$, which are defined as suitable norms of the perturbed electron distribution function. New sufficient conditions for stability and instability are proved for extensive classes of initial distributions and initial perturbations. The results are compared with conclusions on stability and instability reached by Backus. (auth)

**33451** ELECTRON DENSITY PROFILES IN CYLINDRICAL PLASMAS FROM MICROWAVE REFRACTION DATA. Anicin, B. A. (Univ. of Sheffield, Eng.). J. Res. Natl. Bur. Std., 69D: 721-7(May 1965).

Electron density profiles in the afterglow of a stabilized linear pinch were measured using the refractive properties of the plasma column. The deflection angle of a microwave beam refracted by the discharge is observed as a function of beam position. The resulting data lead to an integral equation for the electron density distribution, which is reducible to the Abel integral equation. The electron density is derived from the experimental data by inverting this last equation. The method was checked using direct transmission and interferometric measurements. (auth)

**33452** A STUDY OF THE WAVES SUPPORTED BY A WARM PLASMA SLAB. Caron, P. R. (Aerospace Corp., Los Angeles). J. Res. Natl. Bur. Std., 69D: 729-33(May 1965).

The waves supported by a warm plasma slab are investigated. The transverse resonance equation describing the modes on the slab is obtained and, for certain ranges of plasma frequency, excitation frequency, and plasma temperature, it is shown to be convenient to find the roots of this equation by the intersection of two loci. Using these loci the surface waves and leaky waves supported by the slab are described. (auth)

**33453** TRANSMISSION AND REFLECTION OF ELECTROMAGNETIC WAVES BY A HOT PLASMA. Taylor, Edward C. (Aerospace Corp., Los Angeles). J. Res. Natl. Bur. Std., 69D: 735-9(May 1965).

The relativistic form of the Vlasov equation is used to solve the problem of transmission and reflection of normally incident electromagnetic waves. Transmission and reflection coefficients are derived for a plasma half-space and for a plasma slab, using the assumption that electrons are specularly reflected at the boundaries. These coefficients are functions of the ratio of the electron thermal speed to the vacuum speed of light, indicating that temperature dependence in these cases is a relativistic effect. Nevertheless, it is seen that the nonrelativistic limits of these coefficients differ from those obtained by using the cold-plasma equations since the transition to the zero-temperature limit has a nonuniform character. (auth)

**33454** RADIATION FROM A UNIFORMLY MOVING CHARGE IN AN ANISOTROPIC, TWO COMPONENT PLASMA. Seshadri, S. R.; Tuan, H. S. (Harvard Univ., Cambridge, Mass.). J. Res. Natl. Bur. Std., 69D: 767-83 (May 1965).

The effect of motion of heavy ions on the radiation characteristics of a point charge moving with uniform velocity along the direction of the external magnetic field in a plasma is investigated. For the case of stationary ions, two modes are found to be excited up to zero frequencies for values of the normalized strength of the external magnetic field above a certain minimum value. The result of inclusion of the motion of heavy ions is that the ordinary mode has a resonance at the so-called lower hybrid resonant frequency below which it is not excited and the extraordinary mode is excited up to zero frequencies even for very small values of the normalized strength of the external magnetic field. The power radiated in the ordinary mode in the neighborhood of the lower as well as the upper hybrid resonant frequencies is relatively large. The frequency and the angular spectrum of the emitted radiation as well as the direction of the Cherenkov rays are evaluated for some typical parameter values which include those usually obtained in the exosphere. (auth)

**33455** CYCLOTRON HARMONIC WAVES IN WARM PLASMAS. Crawford, F. W. (Stanford Univ., Calif.). J. Res. Natl. Bur. Std., 69D: 789-805(June 1965).

It was predicted theoretically that cyclotron harmonic waves should propagate in warm plasma confined by a magnetic field and should show cutoff and resonance behavior associated with harmonics of the cyclotron frequency and the upper hybrid resonance frequency. A simplified analysis based on the quasi-static approximation is presented and used to establish the relevant dispersion relations. Computer solutions of these are presented showing the influence of the magnetic field and discharge parameters on the propagation. A number of recent experimental results can be explained in terms of this type of wave motion and serve to establish its validity. This work is discussed briefly. Some of the implications of this mode in laboratory and ionospheric plasma physics are discussed. (auth)

**33456** PROPAGATION OF WAVES ACROSS A MAGNETOPLASMA-VACUUM BOUNDARY. Gallawa, Robert L. (National Bureau of Standards, Boulder, Colo.). J. Res. Natl. Bur. Std., 69D: 807-17(June 1965).

The coupling of electroacoustic and electromagnetic energy at a magnetoplasma-vacuum boundary is studied via the plane wave solution of Maxwell's equations. The effect of the static magnetic field is illustrated graphically. It is found that the coupling depends significantly on the angles, increased coupling being in favor of the grazing angles of transmission. The electron density of the plasma is seen to be an important parameter in most cases. (auth)

**33457** STATISTICAL AIDS TO PLASMA PROBE MEASUREMENTS. Mudford, W. M.; Burrows, K. M. (Univ. of New South Wales, Kensington, Australia). J. Sci. Instr., 42: 346-7(May 1965).

A statistical technique is described which reduces the uncertainties in determining electron concentrations from plasma probe characteristics. Properly randomized observations are found also to yield more reliable probe characteristics. (auth)

**33458** IMPROVED MICROWAVE REFLECTION MEASUREMENT OF PLASMAS PRODUCED BY SHOCK WAVES. Funahashi, Akimasa; Takeda, Susumu (Nagoya Univ., Japan). Kakuyugo-Kenkyu, 14: 260-75(Mar. 1965). (In Japanese)

A microwave reflection probe is applied to the measurement of very high electron densities and collision frequencies in plasmas produced by shock waves. The electron density and collision frequency are calculated from a complex reflection coefficient at the sharp plasma boundary existing at the end of the electromagnetically-driven shock tube. Electron densities from $1 \times 10^{16}$ to $6 \times 10^{11}$ $cm^{-3}$ and electron collision frequencies of the order of $10^{10}$ $sec^{-1}$ were measured by an X-band (9000 Mc) microwave reflection probe for a decaying plasma following that produced by a shock wave reflected at the tube end. The Mach number of the shock wave is ~15 in argon at an initial pressure of 0.3 mmHg. In addition, the electron temperature is estimated from the measured electron density and collision frequency, using the electron

temperature dependence on the electron-ion collision frequency. It is found that the temperature of electrons in the afterglow plasma is sustained for a relatively long time. This same tendency to a slow temperature decrease is estimated from the temperature dependence on the recombination coefficient as described in the previous report. (auth)

**33459** THE RELIABILITY OF MEASURING LOW ELECTRON DENSITY PLASMA BY THE MICROWAVE FREE SPACE METHOD. Shiobara, Shinji (Inst. of Physical and Chemical Research, Tokyo). Kakuyugo-Kenkyu, 14: 433-58(Apr. 1965). (In Japanese)

Electron density measurements of steady state helium plasmas in glass cylinders 17 to 96 mm in diameter are made at 34Gc and at pressures of 0.08 to 1.0 mm Hg and densities of about $5 \times 10^{10}$ to $10^{12}$ $cm^{-3}$. Standard pyramidal horns of 20 db gain and teflon lenses about 75 mm in diameter are used. Errors arising from the multiple reflection between antennas and the spreading of microwave beams incident on plasmas are investigated. It is shown that reliability of more than 90% is attainable for low-density plasmas when an appropriate use is made of the free space method. The reliability obtained by a Langmuir probe method is taken as reference. (auth)

**33460** PHYSICAL MECHANISM OF ION ENTRAINMENT BY THE ELECTRON SPACE CHARGE IN ACCELERATION BY THE GRADIENTS OF STATIC MAGNETIC AND OF ELECTROMAGNETIC FIELDS. Bardet, Rene; Consoli, Terenzio; Geller, Richard (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Fusion, 5: 7-16(Mar. 1965). (In French)

A theory of the physical mechanism of ion entrainment by accelerated electrons is presented. It is shown that under the influence of these fields the electrons describe helices whose diameter and pitch vary along the axis of motion as a function of the difference between the cyclotron frequency and the frequency of the applied h-f field. The space charge thus created accelerates the ions. The coupling between the equations of motion of the electron and ion fluids calls for the introduction of a tensor mass—that of the relativistic mass of the electrons in the two equations in x and y describing the transverse movement of the electrons and that of the ions in the axial motion equation in z. The physical consequences of this theoretical study are then discussed, and three typical experimental results are given that illustrate three of these consequences. (auth)

**33461** INFLUENCE OF HALL CURRENT ON THE STABILITY OF THE PINCH. Buti, B.; Dixit, M. S.; Nayyar, N. K.; Trehan, S. K. (Univ. of Delhi). Nucl. Fusion, 5: 17-19(Mar. 1965).

The effects of the Hall current and electron inertia in the generalized Ohm's law on the stability of the pinch are investigated, using a model with a sheet current and a trapped axial magnetic field both inside and outside the plasma. The fluid is assumed to be incompressible, inviscid, and perfectly conducting and to be surrounded by perfectly conducting walls. In this case, the Hall current and electron inertia are found to have no effect on the stability. (D.C.W.)

**33462** MULTIPARTICLE ASPECTS OF TURBULENT-PLASMA THEORY. Galeev, A. A.; Karpman, V. I.; Sagdeev, R. Z. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nucl. Fusion, 5: 20-40(Mar. 1965). (In Russian)

A review is given of theoretical work performed in connection with a new approach to the theory of a weakly turbulent plasma. The essence of this approach is the representation of turbulent plasma as an aggregate of weakly interacting gases of particles (ions, electrons) and quasi-particles (collective oscillations). In such a scheme are included also instability effects (playing the role of sources in the kinetic equations for quasi-particles). As applications of this method, which is thus a generalization of the known quasi-linear theory, some anomalous transfer phenomena that appear as the result of different types of plasma instability are discussed. (auth)

**33463** SCATTERING OF ELECTROMAGNETIC WAVES BY A CYLINDRICAL PLASMA IN A STEADY MAGNETIC FIELD. I. ANISOTROPY EFFECTS. Vandenplas, P. E.; Messiaen, A. M. (Centre des Sciences Nucleaires, Brussels). Nucl. Fusion, 5: 47-55(Mar. 1965).

The experimental resonance pattern of a cylindrical plasma in a steady magnetic field is compared to theory. The scattering of a plane homogeneous wave by a cold plasma column with a glass wall is studied theoretically. The Poynting vector of this wave is perpendicular to the axis of the cylinder. The static magnetic field $B_0$ is parallel either to the axis or to the Poynting vector S, or perpendicular to both the axis and S. The equilibrium density of the cold plasma is assumed to be constant, and the anisotropy effects due to the homogeneous steady magnetic fields are studied through the equivalent tensorial permittivity. This permittivity is written in a general form so that the treatment also includes the anisotropic dielectric rod. When $B_0$ lies in the cross-section of the cylinder, the partial differential equations cannot be solved in cylindrical co-ordinates. The solution is, however, obtained to second order in $\beta$ (dimensionless parameter proportional to $B_0$) in a Cartesian co-ordinate system; and it is then transformed to a cylindrical system in which the boundary conditions are stated. It is found in most cases that the effect of $B_0$ is much greater for the experimental phenomena than that predicted by the theoretical approach. This discrepancy arises from Laplace forces due to $B_0$ in the cross-section and to the drift velocity of the electrons along the axis of the cylinder, and results in an inhomogeneity of magnetic origin. This magnetically induced inhomogeneity accounts for the data not explained by the anisotropic approach. When $B_0$ is parallel to the cylinder axis, the problem is solved exactly. The Laplace forces do not intervene as $B_0$ is then parallel to the drift velocity. The quantitative agreement is very satisfactory for relatively small values of $B_0$, and poorer results for higher $B_0$ are probably linked to nonproportionality between equilibrium electron density and the discharge current in the plasma column. (auth)

**33464** SCATTERING OF ELECTROMAGNETIC WAVES BY A CYLINDRICAL PLASMA IN A STEADY MAGNETIC FIELD. II. MAGNETICALLY INDUCED INHOMOGENEITY EFFECTS. Messiaen, A. M.; Vandenplas, P. E. (Centre des Sciences Nucleaires, Brussels). Nucl. Fusion, 5: 56-62(Mar. 1965).

The scattering of a plane electromagnetic wave with normal incidence from a cold homogeneous anisotropic plasma cylinder was studied in part I. Comparison with experiments made with a plasma obtained in the positive column of a mercury discharge tube showed that these anisotropic effects were not important enough to explain the reflection behavior. Because of the drift of the plasma along the axis, there is a magnetically induced asymmetrical inhomogeneity when the static magnetic field $B_0$ lies in the cross section of the cylinder. The solution of the problem of the inhomogeneity effects is purely TE as no coupling between TE and TM modes is introduced by the inhomogeneity. It is characteristic that the different angular modes ($n = 1$, $n = 2$, $n = 3$, etc.) are coupled through the inhomogeneity. The magnetic field thus enhances the quadrupolar, hexapolar, etc. effects, in agreement with the experimental data. The inhomogeneity effects suffice to explain the experimental results obtained in reflection (TE mode); the experimental and theoretical electron density ratios corresponding to the first three ($n = 1$, 2 and 3) observable cold plasma peaks are in very striking agreement. As all the n angular modes are coupled, the chain is broken off in the theoretical computations by neglecting the coefficients of a given order n; this is satisfactory as these coefficients tend to zero when n tends to infinity. (auth)

**33465** PROJECT MACETIE (MULTISTAGE ADIABATIC COMPRESSION AND EQUITEMPERATURE IRREVERSIBLE EXPANSION). Uchida, Taijiro (Nagoya Univ., Japan); Hamada, Shigeo; Miyamoto, Kenro; Fujita, Junji;

Inoue, Nobuyuki; Kawasaki, Sunao; Katsumata, Saburo. Nucl. Fusion, 5: 63-7(Mar. 1965).

The principle of Project MACETIE and the preliminary experiment are described. The basis of the plan is the thought that the goal of controlled thermonuclear fusion may be accessible by the multistage alternating processes of adiabatic compression and irreversible expansion of plasma. In the latter process, the plasma compressed by a strong magnetic field is expanded into a region of weaker magnetic field. A static consideration of this expansion suggests that plasma temperature will not change appreciably in this process, and a second adiabatic compression of plasma in the weak field may further increase its temperature. Preliminary experiments are being carried out to examine the foregoing principle of irreversible expansion. (auth)

**33466** PLASMA DENSITY MEASUREMENTS WITH ATOMIC BEAMS. Eubank, Harold P.; Noll, Peter; Tappert, Fred (Princeton Univ., N. J.). Nucl. Fusion, 5: 68-72(Mar. 1965). (MATT-277)

A method is described for the measurement of plasma ion density which relies upon the attenuation of a medium energy atomic beam. For beam energies of a few kev, resonant charge transfer with plasma ions predominates so strongly over competing processes leading to beam attenuation that the determination of ion density is particularly simple. A 2.5 to 5-kev atomic hydrogen beam was used to measure the proton densities produced by a pulsed plasma gun and by the B-1 stellarator. In the latter case a 4-mm microwave interferometer was used to confirm the calculated calibration. The time response of the system is of the order of 1 MHz for density changes $\geq 10^{13}$/cm$^3$. The method appears particularly well suited for ion densities on order of $10^{14}$/cm$^3$ where microwave measurements are difficult. (auth)

**33467** IONIZATION OF FAST HYDROGEN ATOMS IN A STRONG MAGNETIC FIELD. Borovik, E. S.; Busol, F. I.; Kovalenko, V. A.; Skibenko, E. U.; Yuferov, V. B. (Inst. of Physics and Tech., Khar'kov). Nucl. Fusion, 5: 85-6(Mar. 1965). (In Russian)

To determine the fraction of 30-kev hydrogen atoms that were ionized by the Lorentz force in a magnetic field up to 60 kgauss, a direct measurement was performed, unlike the experiment of Sweetman, who evaluated the neutral flux following charge exchange. The beam of neutral hydrogen atoms was obtained from charge exchange of a 30-kev proton beam on a supersonic jet of carbon dioxide in a vacuum of residual pressure $5 \times 10^{-7}$ torr; the beam strength, measured with a small inertial calorimeter (thermocouple) calibrated by an ion beam, was nearly constant during the magnetic pulse. Electrons were removed by a weak electric field. The ions were measured with three collectors (before, in, and after the central magnetic field of 2.2 cm radius); at fields above 25 kgauss all the ions appeared at the central collector that had a sensitivity 0.5 namp. At fields of 55 to 60 kgauss, the fraction (5 to 4) $\times 10^{-4}$ of the hydrogen atoms were ionized by Lorentz ionization, that is an ion current about 0.05 $\mu$amp and an equivalent neutral current about 100 $\mu$amp. From 32 to 51 kgauss, ionization is from the state n = 9, for larger fields from n = 8. (auth)

**33468** PLASMA COMPRESSION BY LIGHT PRESSURE. Caruso, A.; Gratton, F. (EURATOM-CNEN, Frascati, Italy). Nucl. Fusion, 5: 87-8(Mar. 1965).

For giant pulse lasers with light amplifiers, the rise time of the pulse is 0.001 nsec and the duration is 1 nsec. The light from the laser, focused on a speck (10 $\mu$) of solid material, by its pressure can overcome the pressure of a high-temperature and high-density plasma. The initial stage of a plane system is briefly studied, together with (in more detail) the subsequent dynamics. (auth)

**33469** EXCITATION AND DETECTION OF IONIC WAVES IN A DIFFUSION PLASMA. Bardet, R.; Consoli, T. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Letters, 16: 117-19(May 15, 1965). (In French)

Experiments were performed, demonstrating the simultaneous excitation of electron waves at the surface of the plasma column and of ion acoustic waves, having a frequency equal to or double that of the excitation oscillator. The experimental set-up is described, including hot plasma source, differential pump, static magnetic field, piston for containing the plasma column, movable probes, photomultiplier detector, and variable-frequency magnetic modulation of the plasma density. Results for Ar at $7 \times 10^{-4}$ torr are presented and discussed. (M.J.T.)

**33470** A REMARK ON PARAMETRIC GYRORESONANCES OCCURRING IN A PLASMA IN INHOMOGENEOUS ELECTROMAGNETIC FIELDS. Teichmann, J. (Inst. of Plasma Physics, Czechoslovak Academy of Sciences, Prague). Phys. Letters, 16: 119-20(May 15, 1965).

Resonance phenomena appearing through a stationary interaction of a high frequency field with an unbounded plasma are studied in the magnetohydrodynamic approximation. The conditions necessary for the occurrence of a parametric resonance are given, and expressions are obtained for resonance frequencies for different field conditions. Remarks are made on the resonances occurring for multiperiodic and monoperiodic high-frequency fields. (L.B.S.)

**33471** REGIMES OF PLASMA ACCELERATION BY INHOMOGENEOUS HIGH FREQUENCY AND MAGNETOSTATIC FIELD IN A CAVITY RESONATOR. Datlov, J.; Teichmann, J.; Zacek, F. (Inst. of Plasma Physics, Czechoslovak Academy of Sciences, Prague). Phys. Letters, 17: 30-1(June 15, 1965).

Interaction studies between a high frequency field and a plasma in inhomogeneous magnetic fields show that distinct interactions take place not only at frequencies $\omega \sim \omega_{cj}$; but also for a discrete spectrum of frequencies $\omega \neq \omega_{cj}$. Plasma acceleration was observed even in the direction of the stronger magnetic field. This occurs when resonance does not take place in the center of the cavity. Reasons are given for an experimentally observed shift of resonances. (J.F.P.)

**33472** ENERGETIC PLASMA LOSSES DUE TO MICROINSTABILITIES. Dunlap, J. L.; Haste, G. R.; Postma, H.; Reber, L. H. (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 14: 937-9(June 7, 1965). (ORNL-P-1224)

Observation of significant particle losses attributable to microinstabilities in a hot-ion plasma is reported. Energetic ion ejection radially and axially was detected, and the radiofrequency signals and ion losses are correlated. (M.O.W.)

**33473** MEASUREMENT OF THRUST IN A LINEAR HALL ACCELERATOR. Etherington, R. J.; Haines, M. G. (Imperial Coll. of Science and Tech., London). Phys. Rev. Letters, 14: 1019-21(June 21, 1965).

Measurement of the axial mechanical force or thrust acting on the magnetic field coil in a linear plasma Hall accelerator is described. The magnetic field components around a closed path linking the field coil are found by magnetic probes, and the force on the coil is evaluated by integrating the associated magnetic stress tensor. (M.O.W.)

**33474** CYCLOTRON RESONANCE ECHO. Hill, R. M.; Kaplan, D. E. (Lockheed Aircraft Corp., Palo Alto, Calif.). Phys. Rev. Letters, 14: 1062-3(June 28, 1965).

Strong echoes are observed to be radiated from a partially ionized gas plasma following excitation by a sequence of short pulses at the electron cyclotron resonance frequency. These signals have been observed only when the exciting microwave radiation is propagating perpendicular to the magnetic field, and have decay constants which are believed to be determined by the electron relaxation processes in the plasma. (M.O.W.)

**33475** NONLINEAR MODE INTERACTIONS IN UNIVERSAL PLASMA INSTABILITIES. Lashinsky, Herbert (Univ. of Maryland, College Park). Phys. Rev. Letters, 14: 1064-6(June 28, 1965).

An investigation in nonlinear mode interactions in a two-mode system with incommensurate (i.e., not related by integer ratios) mode frequencies is presented. Rate equations representing time dependence of the mode energies

are given, and conclusions derived from these equations are discussed. (M.O.W.)

**33476** COLLISIONAL DAMPING OF PLASMA OSCILLATION—APPLICATION OF THE UNIFIED THEORY. I. COLLISION THEORY. Ogasawara, Masatada (Keio Univ., Japan). Proc. [Fuhihara Mem.] Fac. Eng., Keio Univ. (Tokyo), 17: 1-15(Apr. 1965).

The damping rate of plasma oscillation is calculated by use of the Boltzmann equation for the screened coulomb potential, $\exp(-k_s r)/r$, where r and $k_s^{-1}$ are the distance between particles and the screening distance. The result is required for applying the unified theory. (auth)

**33477** SCATTERING OF A PLANE WAVE FROM AN ANISOTROPIC PLASMA COLUMN AT OBLIQUE INCIDENCE. Ohba, Yujiro (Keio Univ., Japan). Proc. [Fuhihara Mem.] Fac. Eng., Keio Univ. (Tokyo), 17: 16-23 (Apr. 1965).

The scattering of a plane wave by a circular plasma cylinder is calculated in the case of an oblique incidence. The plasma cylinder is lossy and is magnetized in the direction of the cylinder axis. The solution is derived for the magnetic field vector of the incidence plane wave transverse to the cylinder axis. The corresponding result for the electric vector transverse to the axis is also obtained from symmetry of the electric and magnetic vectors in the Maxwell's equations. The modes of the field in the plasma are specified by propagation constants in the radial direction. These constants $S_1$ and $S_2$ are calculated for several sets of values of plasma frequency, cyclotron frequency, and collision frequency. (auth)

**33478** ELECTROMAGNETIC WAVE DIFFRACTION ON A LIMITED PLASMA AT SPACE DISPERSION. Gildenburg, V. B.; Kondratev, I. G. Radiotekhn. i Elektron., 10: 658-64(Apr. 1965). (In Russian)

The problem of the dispersion of plane waves on plasmas of the simplest geometrical form (sphere or cylinder) was solved with calculation of the spatial dispersion in the plasma (in hydrodynamic approximations). Expressions for the amplitude of the dispersed wave and for the amplitude of the electromagnetic and plasma oscillations within the plasma were obtained. The spectra of the electromagnetic and plasma resonances, corresponding to the multipolar oscillations of different orders, were investigated. (tr-auth)

**33479** INTRODUCTION TO THE PHYSICS OF IONIZED GASES AND PLASMAS. Berthelot, Jean. Rev. Gen. Electron., No. 217, 11-16(1964). (In French)

An elementary review is given of the physics of ionized gases and plasmas. The processes of ionization and excitation, atomic structure and classification, distribution of electrons in the complex atom, potential of excitation and ionization, light emission of excited atoms, duration of an excited state, and distinction between light emission and ionization are among the topics discussed. (J.S.R.)

**33480** PLASMA CONTAINMENT FOR NUCLEAR FUSION. Jukes, J. D. (United Kingdom Atomic Energy Authority, Berks, Eng.). Sci. J., 1: No. 3, 32-8(May 1965).

The designs of magnetic containers for maintaining plasma stability are reviewed. Diagrams are given on magnetic mirror traps, flute instability, modified mirror traps, a plasma gun, a pinch trap, a magnetic well, and a cusped bottle. The difficulties encountered in magnetic mirror systems, stellarators, and pinch devices are summarized. Some hope is advanced for thetatron and cusped-bottle devices. (M.H.R.)

**33481** INVESTIGATION OF NON-ISOTHERMAL ARC PLASMA IN ARGON FLUX. Baranov, V. Yu.; Vasil'eva, I. A. (Lenin All-Union Electro-Technical Inst., USSR). Teplofiz. Vysokikh Temp., 3: 173-85(Mar.-Apr. 1965). (In Russian)

The concentration and temperature distributions $n_e$ and $T_e$ of electrons along the argon flux flowing across an arc current were determined by the probe method. By means of the heated filament, the temperature of the gas in the arc column and its vicinity was determined. The measurements were made at pressures from 0.15 to 100 mm Hg at arc currents from 1 to 5 amp and flux speeds from $10^2$ to $5 \times 10^3$ cm/sec. (tr-auth)

**33482** INVESTIGATIONS OF PLASMA CONDUCTIVITY IN A TRANSVERSE MAGNETIC FIELD. Nedospasov, A. V.; Shipuk, I. Ya. Teplofiz. Vysokikh Temp., 3: 186-90 (Mar.-Apr. 1965). (In Russian)

By two independent methods the dependence of the effective conductivities of plasmas perpendicular to the field on $\omega\tau$ was investigated experimentally. The results obtained were discussed. (tr-auth)

**33483** TRANSPORT PROCESSES IN IONIZED GAS. Nastoyashchii, A. F. Teplofiz. Vysokikh Temp., 3: 191-8 (Mar.-Apr. 1965). (In Russian)

The theories of the transport processes in multicomponent plasmas with calculation of the actual principles of particle scattering were examined. The effect of the selection of the shapes of the electron scattering curves on the size of the conductivity of the Cs plasma were preanalyzed. It was shown that for correct calculation of the transport processes the detailed pattern of the curves of the scattering cross section is very necessary. (tr-auth)

**33484** ARC DISCHARGE IN INERT GASES. Kolesnikov, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 30: 66-157 (1964). (In Russian)

A series of experiments showed that at currents below 10 amp in argon and below 200 amp in helium the distribution of excited levels does not follow the Boltzmann law and the degree of molecular dissociation does not correspond to a single temperature. With higher currents, equilibrium is reached at an electron density of $3 \times 10^{16}$/cc in a helium plasma compared to $5 \times 10^{15}$ for argon. The possibility of determining the electron temperature under nonequilibrium conditions from the recombination spectrum is considered. The radial distribution of electron density in a column discharge in argon and helium was measured. The concept of electroconductivity cross-section is introduced, and a method for its experimental determination was developed. The value determined by this method is twice the theoretical value, compared to an order-of-magnitude higher value found by the older method. An equation is given for calculating the value. At 30 to 50 amp the cylindrical form of the plasma column became conical, with a constriction in the precathode region. The electrode material (carbon or metal) had no effect on the plasma state as long as its vapor concentration did not reach 1%. The disagreement of the theoretical and experimental results for nonequilibrium plasma values of the population of excited levels of hydrogen and the coincidence of the temperature distributions indicates that inelastic collisions of atoms and electrons may compete with those of atoms with atoms. The relative probabilities of some optical conversions of atoms (ArI, BaI, and BaII) were measured and some were calculated (LiI, BaI, and BaII). (176 references.) (TTT)

**33485** ON THE TEMPERATURE MEASUREMENTS OF THERMAL PLASMAS OF KNOWN COMPOSITION. Richter, Johannes (Universitat, Kiel). Z. Astrophys., 61: 57-66(Mar. 30, 1965. (In German)

The axial temperature of an argon arc was measured as a function of the arc current strength with various spectroscopic methods. The intensity measurements show that the arc plasma is in thermodynamic equilibrium at temperatures between 10,000 and 15,000°K. Under 900°K and an electron density of $10^{16}$ cm$^{-3}$ appreciable deviations from equilibrium seem to appear. A new method for temperature determination is discussed; it can be used in a thermal plasma of known composition. (tr-auth)

**33486** CALCULATION OF THE TRANSITION PROBABILITIES OF SERIES LIMIT CONTINUA WITH APPLICATION TO THE HEAVY RARE GASES. Schlueter, Dieter (Universitat, Kiel). Z. Astrophys., 61: 67-76 (Mar. 30, 1965). (In German)

The wave function of a free electron in a Coulomb field was determined for small nuclear distances by series

development and for larger distances by numerical integration of the Schroedinger equation. With these functions the transition probabilities for bound-free transitions of the photoelectron were calculated, and the results were applied to the emission continua of thermal plasmas of Ne, Ar, Kr, and Xe. (tr-auth)

**33487** AN UNSTABLE PLASMA BEAM. Nezlin, M. V.; Solntsev, A. M. Zh. Eksperim. i Teor. Fiz., 48: 1237-47(May 1965). (In Russian)

The turbulent state of a plasma beam in which a virtual cathode is formed was studied experimentally. It was shown that this state is characterized by: a broad electric field oscillation spectrum which includes the Larmor ion frequency and which permits one to carry out multiple (stochastic) acceleration of ions up to kilovolt energies by the formation of a strongly eccentric plasma torch rotating in the ion direction with a frequency corresponding to several tens of kilocycles per second, and by acceleration of the ions not only in the transverse but in the longitudinal direction as well. Conditions were determined for transition of the beam to a stable state in which particle acceleration does not occur. (auth)

**33488** SCATTERING OF ELECTROMAGNETIC WAVES BY PLASMA OSCILLATIONS IN A PLANE PLASMA LAYER. Ivanov, A. A.; Ryutov, D. D. Zh. Eksperim. i Teor. Fiz., 48: 1366-71(May 1965). (In Russian)

The scattering of electromagnetic waves by plasma oscillations in a plane plasma layer is investigated. The intensity of the scattered wave is estimated under the assumption that the layer thickness is small compared with the lengths of the incident and scattered electromagnetic waves. The possibility of exploiting the process under consideration for a direct experimental proof of the existence of noise in a turbulently heated plasma is discussed. (auth)

**33489** SOME PROBLEMS OF NONLINEAR THEORY OF OSCILLATIONS IN AN INHOMOGENEOUS PLASMA. Rudakov, L. I. Zh. Eksperim. i Teor. Fiz., 48: 1372-85 (May 1965). (In Russian)

Equations describing the interaction of drift oscillations in a weakly turbulent inhomogeneous plasma are first derived. In contrast to a number of other investigations, the oscillation electric field is not expanded into plane waves, but into quasiclassical functions of the linear problem. It is then shown that if $T_i/T_e < (mH^2/8\pi nT_eM)^{1/4}$, the weakly turbulent state of the plasma is unstable with respect to perturbations of the trough type along the magnetic field. The strong turbulence which appears in this case should lead to destruction of the plasma boundary in a time $\tau \sim (eH/cT_e)\,(n/T_e)^2\,(8\pi nT_eM/H^2m)^{1/4}$. (auth)

**33490** ON THE THEORY OF RUNAWAY ELECTRONS. Lebedev, A. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1393-7(May 1965). (In Russian)

An analytical expression is derived for the electron distribution function in a neutral spatially uniform plasma in the presence of a weak electric field. The dependence of the flux of runaway electrons on the field strength is found. (auth)

**33491** ON THE STABILIZATION OF CERTAIN INSTABILITIES OF A CURRENT-CARRYING PLASMA FILAMENT IN A STRONG MAGNETIC FIELD. Yu. V. Vandakurov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 390-7(Mar. 1965). (In Russian)

The stability with respect to perturbations of the form $f(r)\exp i(\omega t + m\varphi + kz)$ of a plasma cylinder having uniform temperatures and a parabolic radial density distribution is discussed in the magnetohydrodynamic approximation for the following two cases: (1) the plasma filament is located in a strong constant longitudinal magnetic field and the ion Larmor radius is finite; (2) the plasma filament is located in a strong longitudinal magnetic field upon which is superposed a longitudinal oscillating magnetic field with frequency large compared with the reciprocal of the thermal relaxation time and small compared with the ion Larmor frequency, and the ion Larmor radius is treated as infinite. The effect of finite ion Larmor radius is included in the expression for the viscous stress tensor. Stability conditions are derived from the dispersion equation in case (2) only for long-wavelength, low-frequency perturbations. It is found that in both cases perturbations for which m exceeds unity can be stabilized under certain conditions. Free oscillations of the plasma filament are also discussed briefly. (ATD)

**33492** ON RETARDATION OF FLUTE INSTABILITY DEVELOPMENT BY STRONG INTERACTION OF THE PLASMA WITH A NEUTRAL GAS. Vandakurov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 398-401(Mar. 1965). (In Russian)

The development of flute instability in a thin plasma filament in a spatially periodic longitudinal magnetic field is discussed in the magnetohydrodynamic approximation with the effect of collision between the ions and neutral atoms taken into account. The temperatures of the ions and the neutral particles were assumed to be equal, and the interaction between electrons and neutrals and the velocity acquired by the neutral gas from the plasma were neglected. It was found that when the ratio f/I of the ion-neutral collision frequency to the logarithmic increment of the flute instability in the absence of neutrals is large, the collisions decrease the logarithmic increment of the instability by the factor 2I/f (if the mass of the neutral atoms is equal to that of the ions). The case of a current-carrying plasma filament is discussed briefly, and it is shown that collisions with neutrals decrease the logarithmic increment of the developing instability in this case also. (ATD)

**33493** ON THE NONLINEAR INTERACTION OF A CHARGED PARTICLE BEAM WITH A PLASMA. Giorgadze, N. P. (Inst. of Physics, Tbilisi, USSR). Zh. Tekhn. Fiz., 35: 416-20(Mar. 1965). (In Russian)

The propagation of electromagnetic waves in a cold plasma traversed by a cold electron beam is discussed in the magnetohydrodynamic approximation. The motions of the ions are neglected except insofar as they compensate the constant part of the beam current. The magnetohydrodynamic equations are subjected to a Fourier transform and are solved in the first nonlinear approximation by the usual iteration procedure for the case in which the zeroth (linear) approximation represents a longitudinal wave. The expression found for the longitudinal part of the first nonlinear approximation reduces for the case of waves propagating parallel to the electron beam to the expression given by M. Sumi (J. Phys. Soc. Japan 15, 1086, 1960). The transverse part of the nonlinear wave is discussed for wavelengths long compared with the ratio of the beam velocity to the Langmuir frequency, where it exceeds in intensity the transverse wave that appears in the linear approximation. It is found that under certain conditions longitudinal oscillations can give rise to transverse oscillations, and the plasma can accordingly lose energy by radiation. This effect is ordinarily weak but can be important under conditions when longitudinal oscillations with increasing amplitude appear. (ATD)

**33494** EXCITATION OF OSCILLATIONS IN A PLASMA BY A FLUX OF OSCILLATORS. Lominadze, D. G.; Stepanov, K. N. (Inst. of Physics, Tbilisi, USSR and Physicotechnical Inst., Academy of Sciences, Ukrainian SSR). Zh. Tekhn. Fiz., 35: 441-8(Mar. 1965). (In Russian)

A study is made of the excitation in a plasma of oscillations propagating nearly perpendicularly to an external magnetic field by a stream of ion oscillators, all having the same Larmor radius. Oscillations of the plasma are considered for which the wavelength is short compared with the Larmor radius of the exciting ions and the frequency is high compared with their Larmor frequency. The contribution of the ion beam to the dielectric tensor is given in the form of an infinite series of Bessel functions whose arguments are the large ratio of the Larmor

radius to the wavelength. The dielectric tensor is accordingly transformed to a form that converges more rapidly under the conditions of the problem, and the roots of the dispersion equation are discussed for ordinary, extraordinary, and longitudinal waves. The dispersion equation has roots not only at frequencies near harmonics of the electron Larmor frequency and the hybrid frequency, but also at a frequency close to the ratio of the ion beam velocity to the wavelength. The logarithmic increment of the longitudinal waves is much greater than that of the transverse waves; it is proportional to $(n'/n)^{\frac{1}{3}}$, where n' and n are the particle densities of the ion beam and the plasma, respectively. If the plasma contains no ions except those of the beam, it is unstable under all conditions. Instability of this type may be expected to arise in high density adiabatic magnetic mirror systems in which the ion velocity distribution is highly anisotropic. (ATD)

**33495** EXCITATION OF LOW-FREQUENCY LONGITUDINAL OSCILLATIONS IN A PLASMA BY A STREAM OF CHARGED PARTICLES WITH AN ANISOTROPIC DISTRIBUTION FUNCTION. Lominadze, D. G.; Stepanov, K. N. (Inst. of Physics, Tbilisi, USSR and Physicotechnical Inst., Academy of Sciences, Ukrainian SSR). Zh. Tekhn. Fiz., 35: 449-58(Mar. 1965). (In Russian)

A study is made of the excitation of low-frequency longitudinal oscillations of a plasma in the presence of an external magnetic field by a stream of charged particles having a delta-function distribution of velocity components perpendicular to the magnetic field and a Maxwellian distribution of the velocity component parallel to the field. The dispersion equation is written, and its solutions are discussed at considerable length. Long wavelength oscillations occur with phase velocities much greater than the thermal velocities of the plasma particles and, in the case of a highly anisothermal plasma, with phase velocity intermediate between the ion and electron thermal velocities. Longitudinal ion cyclotron waves with wavelength of the order of the plasma ion Larmor radius propagate nearly at right angles to the magnetic field. The excitation of longitudinal oscillations is discussed separately for the case of a hot beam (broad distribution of the velocity component parallel to the magnetic field) and for that of a cold beam. Formulas are derived for the logarithmic decrement (or increment) of the various waves, and the conditions for the stability of the system are discussed. (ATD)

**33496** ON THE CYCLOTRON EXCITATION OF MAGNETOACOUSTIC WAVES BY A STREAM OF CHARGED PARTICLES. Angeleiko, V. V.; Kitsenko, A. B. Zh. Tekhn. Fiz., 35: 470-4(Mar. 1965). (In Russian)

The interaction of a neutral stream of charged particles with the low-frequency oscillations (fast and slow magnetoacoustic waves) of a highly anisothermal plasma in an external magnetic field is discussed. The magnetic and kinetic pressures are assumed to be of the same order of magnitude, and the interaction is discussed in the neighborhood of the cyclotron resonance under conditions of the anomalous Doppler effect. The relevant dispersion equation is quoted from earlier work and is simplified for the case in which the frequency is low compared with the ion Larmor frequency and the phase velocity is high compared with the ion thermal velocity and low compared with the electron thermal velocity. Solutions are obtained and discussed separately for the case of a hot beam and that of a cold beam, and for conditions of cyclotron resonance with the ions and with the electrons of the beam. (ATD)

**33497** ON THE DIFFUSION THEORY OF THE POSITIVE COLUMN. Belousova, L. E. Zh. Tekhn. Fiz., 35: 475-85(Mar. 1965). (In Russian)

The equilibrium equations for a positive column with volume recombination and stepwise ionization taken into account are solved by expanding the electron and ion densities and the electric field strength in powers of the distance from the axis. The coefficients in these expansions are first evaluated with volume recombination and stepwise ionization neglected, and the resulting electron and space charge distributions are compared with those calculated with the aid of a computer. The expression obtained for the electron density is shown to be equivalent to the closed expression given by Schottky in the limit in which the latter is valid. The effects of volume recombination and stepwise ionization are then included and the distributions are calculated for a plasma bounded, not by a cylindrical wall, but by a sphere or by two parallel planes. The peak in the space charge distribution found by Allis and Rose for the plane-parallel case does not occur. Expressions are derived for the charge density on the axis or at the center of the plasma, and it is concluded that the charge density at the center of the dense spherical plasma is determined by the radius of the sphere, the pressure, and the nature of the gas. (ATD)

**33498** ON THE ACCELERATION OF PLASMA IONS PRODUCED DURING INTERRUPTION OF A CURRENT BETWEEN ELECTRODES IN A VACUUM. Tyulina, M. A. (All-Union Electricotechnical Inst., Moscow). Zh. Tekhn. Fiz., 35: 511-15(Mar. 1965). (In Russian)

The velocities of ions in the plasma produced by the operation of a vacuum circuit breaker were investigated experimentally. Direct currents of 50 to 300 amp from a 110 v source were interrupted by separation in vacuo at a speed of approximately 50 cm/sec of 1 cm diameter cylindrical tungsten or molybdenum electrodes. The potential drop across the arc was 20 v, and the duration of the arc was from 5 to 25 μsec. Both electron and ion currents were measured by probes located in the contact plane of the electrodes at various distances to 15 cm from them. Ion velocities were determined from the time of flight. Ion velocities from $1.3$ to $2.0 \times 10^6$ cm/sec were observed, corresponding to energies from 140 to 300 ev. The electron velocities were the same or somewhat greater than the ion velocities. The plasmas were not uniformly distributed in azimuth; plasma densities of $10^{12}$ $cm^{-3}$ were observed at 1 cm from the electrodes; the variation of current with distance was such as to indicate the absence of appreciable recombination. Increasing the interrupted current by a factor 6 increased the ion velocity by a factor 1.5. Possible mechanisms are discussed by which the (relatively) high energy ions might be produced in the low voltage arc, and it is concluded that the ambipolar acceleration mechanism proposed by H. W. Hendel and T. T. Reboul (Phys. Fluids, 5: 360(1962)) and others, according to which the ions are accelerated by the space charge of faster electrons, is adequate to explain the results. (ATD)

**33499** TEMPERATURE AND DENSITY DISTRIBUTION IN A HOT STATIONARY ARC. Alikhanov S. G.; Ivaniya, S. P. Zh. Tekhn. Fiz., 35: 557-61(Mar. 1965). (In Russian)

In order to explore one of the possibilities inherent in the suggestion that a hot plasma might be thermally insulated from a surrounding dense gas by a magnetic field, the steady state equations for an axially symmetric completely ionized deuterium arc were solved numerically. The results are presented graphically and are discussed briefly. The thermally insulating magnetic field was assumed to be that due to the arc current (pinch in a gaseous shell). Both electron and ion heat conduction were included in the equations, the electron and ion temperatures were assumed to be equal, and energy loss by radiation was neglected. The steady state equations involve the parameter $T^6/p$, where T and p are the temperature and pressure on the axis of the arc. Solutions were obtained for values of this parameter ranging from $10^{17}$ to $10^{34}$ $(°K)^6$ $cm^3$/dyne. The results are not in agreement with previous calculations which find the pinch to be surrounded by a thick dense shell of cold plasma; present calculations show that the density rises sharply only in a thin layer at the wall of the confining vessel. It is concluded that the solution of the steady state equations with the classical transport coefficients provides no basis for hope that a very hot stable plasma might be achieved without employing special means for its stabilization. It is expected to be able to isolate the hot plasma from impurities coming from the wall of the chamber. (ATD)

**33500** EXPERIMENTAL INVESTIGATION OF THE ACCELERATION OF PLASMA BY THE ACTION OF A UHF FIELD GRADIENT. Gekker, I. R.; Konstantinova,

T. G.; Luk'yanchikov, G. S.; Sergeichev, K. F. Zh. Tekhn. Fiz., 35: 577-80(Mar. 1965). (In Russian)

The acceleration of hydrogen plasma by a highly nonuniform uhf field was investigated. Plasma from a mica spark plasma gun was projected into the open end of a circular waveguide excited by pulsed uhf power at a frequency below its cutoff frequency. The exciting frequency was 3000 Mc. The energy distribution of the ions in the plasma ejected from the waveguide by the action of the exponentially decreasing uhf field was determined with a three-electrode probe. The observed energy distributions were bimodal. When the maximum uhf field strength was 4 kv/cm, ions with energies up to 580 ev were present. It is pointed out that acceleration of plasma by a uhf field gradient is most efficient when the frequency of the field is close to the Langmuir frequency of the plasma, and it is concluded that by using uhf fields of the order of 100 kv/cm and plasma densities near the resonance value it should be possible to obtain high densities of plasma ions with energies of hundreds of kev. (ATD)

**33501** WAVE TRANSFORMATION AT A PLASMA-VACUUM BOUNDARY. Loladze, Ts. D. Zh. Tekhn. Fiz., 35: 582-4(Mar. 1965). (In Russian)

The reflection and refraction of MHD waves at the boundary between an anisotropic plasma and vacuum in the presence of a constant magnetic field parallel to the boundary is discussed. The plane of incidence is assumed to be parallel to the applied magnetic field and to contain the electric vector of the polarized incident wave. The dispersion equation for a rarefied anisotropic plasma on which the calculations are based is taken from previous work. The incident MHD wave gives rise to two reflected waves, a magnetic sound wave and an anisotropic Alfven wave, and under some conditions to a refracted transverse electromagnetic wave in the vacuum. Formulas are derived for the amplitudes of these reflected and refracted waves. The case of an incident anisotropic Alfven wave is also discussed briefly. Such waves do not give rise to electromagnetic waves in the vacuum. (ATD)

**33502** TRANSPORT THEORY OF WAVE PROPAGATION IN A COLLISION-FREE PLASMA. Buenemann, D. Thesis, Kiel, Universitat, 1964. 89p. (In German). $2.00 (Gmelin, AED-DISS. 64-466)

The effect of electromagnetic fields on a plasma results in a perturbation of the distribution function. Methods for the solution of the Boltzmann equation are discussed. A dispersion relation for arbitrary distribution functions is given. (tr-auth)

**33503** PROCESS OF FORMATION AND ACCELERATION OF PLASMA AND A GUN FOR ITS APPLICATION. (to European Atomic Energy Community (EURATOM)). British Patent 979,090. Jan. 1, 1965. Priority date Sept. 9, 1962, France.

A process is described for the formation and acceleration of plasma in which a certain amount of gas intended to form the plasma is liberated in an evacuated chamber and then submitted to a discharge. This discharge produces the formation of an ionized ring that expands and triggers a second discharge that brings about the ejection of the ring. A plasma gun is provided for the application of the process and is particularly applicable to the production of a thermonuclear reaction or in propulsion by plasma. (B.L.M.)

**33504** IMPROVEMENTS IN OR RELATING TO NUCLEAR FUSION REACTORS. Hansen, Siegfried; Fonda-Bonardi, Giusto (to Litton Industries Inc.). British Patent 993,174. May 26, 1965. Filed Aug. 10, 1962.

In a nuclear fusion reactor two plasma masses comprised of the same composition of deuterium-tritium are directed to a common collision region. Both plasmas are made up of groups of particles accelerated in opposite directions along collinear axes by linear accelerators to substantially equal velocities and have sufficient energy to fuse upon collision. The plasma is maintained in an essentially ring-shaped mass. Both accelerators are supplied from a common gas source of deuterium-tritium mixture by way of an ionization chamber(s). Means are provided for recirculating the particles not involved in collision from the collision region to the plasma accelerators. (B.L.M.)

**33505** INJECTION SYSTEM FOR ELECTRIC DEVICE. Leboutet, Hubert (to Compagnie Generale de Telegraphie Sans Fil). U. S. Patent 3,166,477. Jan. 19, 1965. Priority date Dec. 24, 1958, France.

The injection system for a plasma includes a chamber for the production of high temperature in communication with the injection chamber. The passage of particles from one chamber to the other between injections is effectively prevented by a magnetic mirror with a controlled opening that opens at the moment of injection to operate as a magnetic shutter. Prior to opening of the magnetic shutter, the plasma is injected into the injection chamber where it is confined and compressed in a second magnetic bottle that is closed on one side by the magnetic shutter and on the other by a movable magnetic mirror operating as a magnetic piston to push or displace the plasma toward the shutter. (B.L.M.)

**33506** PLASMA ACCELEPATOR. Wood, George P.; Carter, Arlen F. (to National Aeronautics and Space Administration). U. S. Patent 3,171,060. Feb. 23, 1965. Filed Mar. 7, 1962.

A steady-flow, linear, d-c, electromagnetic, cross-field plasma accelerator is patented. An accelerating channel has electric and magnetic fields oriented normally to each other. The electric field, in addition to being normal to the magnetic field, is also slanted in an axial downstream direction so as to cause the positive ions of the plasma to flow nearly parallel to the channel axis. The slanted electric field is provided by a plurality of axially spaced, segmented electrodes, which define opposing channel walls. The cathodes of the segmented electrodes also serve as thermionic emitters that, when heated by the plasma flow, emit an electron current. The driving force on the plasma is dependent upon both the density of the electron current and the induction of the imposed magnetic field. (A.G.W.)

**33507** PLASMA CONFINING DEVICE. Leboutet, Hubert; Dolique, Jean-Michel (to Compagnie Generale de Telegraphie Sans Fil). U. S. Patent 3,174,068. Mar. 16, 1965. Priority date May 14, 1959, France.

The plasma contained within an annular enclosure provided with magnetic mirrors is confined not only by the static magnetic field but also by an electromagnetic field of a high-frequency wave propagating in a closed circuit or loop within the conduit formed between the plasma and the walls of the enclosure. (A.G.W.)

**33508** CONTINUOUSLY OPERATING INDUCTION PLASMA ACCELERATOR. Barger, Raymond L.; Brooks, Joseph D.; Beasley, William D. (to National Aeronautics and Space Administration). U. S. Patent 3,174,278. Mar. 23, 1965. Filed Jan. 24, 1963.

The plasma accelerator patented is capable of producing supersonic speeds and is operable over a wide pressure range. The accelerator has a flow chamber into which an ionizable gas is introduced upstream of a nozzle. A ring of ionized gas is maintained downstream of the nozzle by a r-f coil surrounding the flow chamber. An induction or driver coil surrounds the nozzle of the flow chamber and provides a source of high power for greatly increasing the ionization of the gas. The ionized gas operates as a secondary coil in which a current is induced by the primary. An iron core mounted in the flow chamber in a manner such that it extends downstream through the ionized gas ring causes the magnetic lines linking the current ring induced in the ionized gas to be radially directed. The radial magnetic lines interact with the current induced in the gas to provide a force in the direction of plasma flow. (A.G.W.)

**33509** MAGNETOHYDRODYNAMIC FLUID ACCELERATOR AND COMPRESSOR. Hurwitz, Henry, Jr.; Koenig, Harold R. (to General Electric Co.). U. S. Patent 3,183,403. May 11, 1965. Filed Oct. 6, 1960.

An apparatus is provided for accelerating and compressing a plasma without utilization of moving parts. An ionized gas flows through a channel, and electrodes are provided at either end of the channel in contact with the gas entering and leaving the channel. A magnetic field is established transverse to the flow of ionized gas. An electric potential is applied between the electrodes establishing an electric field along the longitudinal axis of the channel. The interaction of the electric field with the ionized gas establishes an electric current with a transverse component that impresses a force upon the gas in the direction of the applied electric field when a suitable external circuit is provided to facilitate the transverse electric current. With appropriate choice of channel size and shape, the plasma may be compressed, as well as, or instead of, accelerated. (B.L.M.)

# Shielding

*Refer also to abstract 32499.*

**33510** ANGULAR DISTRIBUTION OF γ BREMSSTRAHLUNG FROM A THICK TARGET. Mamedov, R. A.; Kramer-Ageev, E. A.; Pozdnyak, V. I. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz. Tekhn. i Mat. Nauk, No. 3, 131-4 (1964). (In Russian)

The yield of bremsstrahlung up to angles of ~140° is calculated for a target thickness of $t \sim 10\ \chi$, where t is the thickness and $\chi$ is the radiation length. The results of the calculations are presented for three wall thicknesses of 24, 11, and 5 Mev. A wall thickness equal to the range of 11-Mev electrons (2 cm of Al) turned out to be the least sensitive to the energy of the radiation. A calculated plot of the counter readings as a function of wall thickness (cm of Al) is in good agreement with the experimental values. The yield of gamma radiation from a thick target decreases only slightly with increasing angle at $\theta > 50$ to 60° and is about 10% of the direct forward yield. This method can be readily used to measure dose rates up to 20 R/hr. (TTT)

**33511** THE EFFECT OF ABSORBER POSITION ON SCATTERING IN MEASUREMENT OF BETA RAY ABSORPTION. Hattori, Taikichi (Muroran Inst. of Tech., Japan). Muroran Kogyo Daigaku Kenkyu Hokoku, 4: 297-305(June 1964). (In Japanese)

A method is described by which the counting rate of radiated beta particles is kept constant regardless of absorber position. The curves of the counting rate plotted against the absorber position can be classified into three fundamental types: (1) V type with a minimum in the counting rate, (2) inverted V type with a maximum and (3) monotonically increasing (or decreasing) type. The results of experiments show that the degree of collimation has a remarkable influence on the form of the curves. The monotonically increasing type gradually transforms into the inverted V type, and the same situation occurs for the V type as the hole diameter of collimator is made small. Thus the optimum diameter to make the curves the flattest is obtained. By using this optimum diameter the measurement of thickness or density of continuously moving materials can be performed with higher precision. In case of extremely collimated radiation the curves ultimately become the monotonically decreasing type. These experimental results agree with those of a simple theoretical calculation. (auth)

**33512** SLOWING OF CHROMIUM ATOMS WITH AN ENERGY OF 20 TO 90 ev IN DIFFERENT SUBSTANCES. Kalus, Juergen (Technische Hochschule, Munich). Z. Naturforsch., 20a: 391-4(Mar. 1965). (In German)

The slowing paths of Cr atoms in $V_2O_5$, V, $VOC_2O_4$, $V(CH-(COCH_3)_2)_3$, $VO(CH-(COCH_3)_2)_2$, V dissolved in dilute $HNO_3$, $VOSO_4$ dissolved in $H_2O$, and $VH(SO_4)_2$ dissolved in dilute $HNO_3$ were determined in the energy range from 20 to 90 ev with the help of nuclear resonance fluorescence. The slowing paths were about 2 Å and increased in compounds and solutions up to 6 Å. (tr-auth)

# Solid State Physics

**See also CHEMISTRY — Inorganic and Physical Chemistry**
**METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure**

*Refer also to abstracts 32673 and 33336.*

**33513** (AD-611194) SPECTROSCOPIE DE DEFAUTS PONCTUELS. (Spectroscopy of Point Defects). Balkanski, M.; da Silva, E.; Nazarewicz, W. (Paris Univ. (France). Laboratoire de Physique). Sept. 15, 1963. Contract AF61(052)-572. 25p. (AFOSR-5431; TN-3). $1.00(CFSTI).

The absorption spectra of such impurities as oxygen, carbon, and nitrogen are being studied in the lattice of silicon and molecular vibrations are obtained at 9 microns, 12.2 microns, and 10.6 microns, respectively. High-density defects, created by irradiation with fast neutrons, polarize the lattice and make it possible to observe the direct photon-phonon interaction. The infrared absorption spectra due to single phonons are composed of bands at 488, 417, and 331, as well as at 140/cm, corresponding to modes TO, LO, LA, and TA, respectively. The energies of TO, for example, are determined under high resolution at the point of maximum density of modes at Γ, L, W, and X. They are 516.5 ± 1, 488.5 ± 1, 474 ± 1, and 447 ± 1. (auth)

**33514** (COO-587-17) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report, February 16—May 15, 1965. Noble, Gordon (IIT Research Inst., Chicago, Ill.). June 5, 1965. Contract AT(11-1)-587. 47p. (IITRI-1184-17). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A "hole" may be burned in the magnetic resonance spectrum of the F-center at 4°K. The experimental method of saturation at fixed field and frequency followed by observation by field scan as described previously in these reports is retained. However, the saturation pulses of $10^{-2}$ sec in duration are used. Under these conditions the observation shows a resonance with structure at suitable power levels. The difference between observation fields corresponding to maximum saturation is constant and independent of the ratio of the saturating field and frequency. The optical emission band of F-centers in RbCl is described in terms of width, shape, and moments. It is found that the single effective frequency approximation is valid and the value of this parameter as determined from the temperature dependence of the width is close to that for absorption in the same samples. Other relationships between absorption and emission parameters are noted. The method of moments yields a Huang-Rhys factor of 53 for emission in contrast to 28 for absorption although the band shapes are closely related. Definite impurity effects are noted in the width at 4°K. (auth)

**33515** (IS-T-10) THE EFFECT OF PRESSURE ON F-CENTER LUMINESCENCE (thesis). Brothers, Alfred Douglas, Jr. (Ames Lab., Iowa State Univ. of Science and Tech.). May 1965. Contract W-7405-eng-82. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Measurements of the pressure shift of the peak energy of the F emission spectra of KBr, KCl, and KI crystals additively colored with potassium were made. The values obtained were $1.89 \times 10^{-5}$ ev/atm, $2.25 \times 10^{-5}$ ev/atm, and $2.07 \times 10^{-5}$ ev/atm respectively. The peak energy shift of M emission in KBr and R emission in KCl were also determined to be $2.54 \times 10^{-5}$ ev/atm and $1.20 \times 10^{-5}$ ev/atm respectively. A pressure-induced splitting of the F emission band of KBr into two components, 0.02 ev apart, was observed. The higher energy component grows with pressure until at 50,000 psi it appears equal in magnitude to the original single peak present at atmospheric pressure. A substantial increase in halfwidth with pressure in KBr and KI, from 0.215 ev to 0.260 ev and from 0.160 ev to 0.216 ev

respectively, with increasing pressure to 57,500 psi was noted. Possible relations between the increased halfwidths and the appearance of the new emission component are suggested. (auth)

**33516** (ORNL-3794) OR TEP—A FORTRAN THERMAL-ELLIPSOID PLOT PROGRAM FOR CRYSTAL STRUCTURE ILLUSTRATIONS. Johnson, Carroll K. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 128p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

A computer program is described for drawing crystal structure illustrations with a mechanical plotter. Ball-and-stick type illustrations of a quality suitable for publication are produced with either spheres or thermal-motion probability ellipsoids on the atomic sites. The program can produce stereoscopic pairs of illustrations which aid in the visualization of complex packing arrangements of atoms and thermal motion patterns. Interatomic distances, bond angles, and principal axes of thermal motion are also calculated to aid the structural study. The FORTRAN coding utilizes the comparable features of IBM 709/7090 FORTRAN II and CDC 1604/1604A FORTRAN 63 so that the program can be executed on a number of different machines which have 32 K word memories. The machine-oriented plotting subroutines are standard library-type routines with slight modifications. Both CalComp and Benson Lehner off-line magnetic-tape plotting systems have been used successfully. Sample stereo-figure illustrations and a viewer are included. (auth)

**33517** (TID-21923) ELECTRONIC PROPERTIES OF DEFECTS IN IONIC CRYSTALS. Progress Report, May 1965. Fitchen, Douglas B. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Contract AT(30-1)-3464. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The studies in the past year have been concerned with the observation and interpretation of fine structure in the optical spectra of color centers in the alkali halides. Experiments in progress are (1) an intensive study, through absorption and emission spectra, of the electronic properties and electron-phonon interaction at those color centers which exhibit zero-phonon lines and discrete phonon structure, and (2) a study of the fine structure of the F-center absorption in the cesium halides, particularly CsF. (auth)

**33518** (TID-21946) CRYSTAL FIELD EFFECTS IN ZIRCONIUM OXIDE (thesis). Meehan, John Patrick (Temple Univ., Philadelphia, Pa.). May 1965. Contract AT(30-1)-2082. 92p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Zirconium oxide was doped with chromium and vanadium at concentration levels of ~1%. Optical and paramagnetic resonance spectra of the doped systems were obtained and are interpreted by means of ligand field theory. From the optical spectrum of the $ZrO_2$: Cr systems, it is suggested that the chromium (III) occupies a zirconium site, and is surrounded by a distorted octahedron of oxygen ions. The paramagnetic resonance spectrum of the $ZrO_2$: Cr system substantiates the contention that the chromium (III) experiences a distorted crystal field. The presence of chromium (VI) in the $ZrO_2$ lattice is inferred from the appearance of an intense charge transfer band above 30,000 $cm^{-1}$. The optical spectrum of the $ZrO_2$: V systems indicates that a charge transfer process is responsible for the intense absorption above 19,000 $cm^{-1}$. This strong absorption suggests the presence of vanadium (V) in the $ZrO_2$ lattice. The magnetic resonance spectrum of $ZrO_2$: V reveals the presence of vanadium (IV) in the lattice. This oxidation state is represented as $VO^{+2}$, the vanadyl ion. In both the chromium-doped $ZrO_2$ and the vanadium-doped $ZrO_2$, it appears that two different oxidation states of the same element are present in the lattice simultaneously. Information on the nature of the chemical bonding in the zirconium oxide is obtained by considering the optical spectrum of the $ZrO_2$: Cr system. The reduction of the $^4F$-$^4P$ term separation, and the reduction of the Racah B parameter for the chromium (III) ion in $ZrO_2$ both indicate that the interelectron repulsion energy for the chromium (III) ion in the $ZrO_2$ lattice has been reduced. This, in turn, indicates an exchange of electrons between the chromium and the surrounding lattice. This exchange of electrons represents a deviation from purely ionic behavior, and is associated with covalency of the metal-oxygen bond. It is found that the $^4F$-$^4P$ term separation and the Racah B parameter for chromium (III) in $ZrO_2$ are only about 70% of the values for the free chromium (III) ion. From this it is inferred that the bonding in the $ZrO_2$: Cr system is roughly 70% ionic and 30% covalent. This covalency in the bonding in $ZrO_2$ is also suggested by the results obtained from a very approximate Born-Haber calculation of the heat of formation of $ZrO_2$. (auth)

**33519** (USNRDL-TR-845) NEAR INFRARED ABSORPTION BAND IN CADMIUM SULFIDE SINGLE CRYSTALS. Alvares, N. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 26, 1965. 32p.

Measurements of the absorption spectra of cadmium sulfide single crystals were made in the region of 0.5 to 15 microns and between the temperatures of 90 and 293°K. An absorption peak observed at 3.1 microns is apparently generated by a process of thermal stimulation. It appeared after the crystal was heated from 90°K to 140°K or stored for long periods of time at 90°K. The 3.1 micron absorption peak is an indication of a trapping site with an energy of 0.4 ev. In order to verify this observation, a thermally stimulated current measurement was made with a CdS single crystal. The result of this measurement was that the location of the current peak essentially confirmed the optically observed trapping energy of 0.4 ev. The time response of gamma-induced current for the crystals in a flux of 10 r/hr was measured, and an attempt was made to correlate the time response measurements to the magnitude of the optical absorption peak; however, due to anomalies in the time response measurements, no definite comparisons could be made between these two parameters. The optical observations were able only to detect the presence of the absorption band, and not its energy location within the band structure of the crystal. (auth)

**33520** (AEC-tr-6585) EFFECT OF OXYGEN CONCENTRATION ON THE ELECTRIC AND THERMOELECTRIC PROPERTIES OF COMPOUNDS OF THE TERNARY $Bi_2Te_{3-x}Se_x$ SYSTEM. Smirous, K.; Stourac, L. Translated from Czech. J. Phys., 10: 659-62(1960). 7p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

The electric conductivity of $Bi_2Se_{0.6}Te_{2.4}$ decreased 40% upon addition of 0.01 mole % $Bi_2O_3$, but remained constant thereafter to 0.1 mole % $Bi_2O_3$. There was no significant change in the thermal emf. Measurement of the Hall constant led to the conclusion that the decrease in electric conductivity was due to a decrease in the electron mobility instead of a reduction in electron concentration. (W.L.G.)

**33521** (ORNL-tr-536) ON THE RELATIONSHIP OF THE CHARACTERISTIC ENERGY LOSSES TO TEMPERATURE AND SCATTERING ANGLE. Meyer, G. Translated for Oak Ridge National Lab., Tenn., from Z. Physik, 148: 61-71(1957). 16p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

Experiments are described in which the relation of the mean energy loss to the object temperature was measured with Al and Ge by means of the retarding potential method. The results agree with the findings obtained from plasma theory with consideration of the thermal expansion of the crystal. Furthermore, the form, position, and intensity of the energy distribution of inelastically scattered electrons were investigated as a function of the angle of scattering. Here, again, the statements of theory with respect to the magnitude of the loss and the maximum angle of scattering could be confirmed with Al. (auth)

**33522** SPIN-SPLITTING OF THE DE HAAS-VAN ALPHEN OSCILLATIONS IN THE ULTRASONIC ATTENUATION IN ZINC. Myers, A.; Bosnell, J. R. (Leeds Univ., Eng.). Phys. Letters, 17: 9-10(June 15, 1965).

An investigation of the line shape of the de Haas-Van Alphen type oscillations in the ultrasonic attenuation in a zinc single crystal of 99.9999% purity is reported. The high values obtained are interpreted in terms of spin-orbit coupling. Each oscillation is split into two peaks, one asso-

ciated with a particular Landau level and spin up and the other with the same level and spin down. The angular dependence of the computed effective g-factors is in good agreement with predicted values. These effective g-factors for spin splitting provide information about the energy spectrum in zinc. (J.F.P.)

**33523** INFRARED ABSORPTION STRUCTURE IN RARE-EARTH METALS: RELATIONSHIP TO SPIN ARRANGEMENT AND BAND STRUCTURE. Cooper, B. R.; Redington, R. W. (General Electric Research Labs., Schenectady, N. Y.). Phys. Rev. Letters, 14: 1066-9 (June 28, 1965).

The appearance of structure at about 0.35 ev in the infrared reflectivity for a holmium film in the temperature range where holmium has a spiral spin arrangement with periodicity along the c axis was previously reported. A definitive experiment is pointed out for distinguishing whether this structure, or any part of the infrared absorption for the heavy rare-earth metals, is associated with the spiral periodicity. The infrared absorption for dysprosium is shown to be completely independent of any periodicity associated with the spiral. It is pointed out that in the light of recent band calculations there is an alternative explanation for the occurrence of such low-frequency structure for the heavy rare-earth metals. (M.O.W.)

**33524** ELECTRON-NUCLEAR DOUBLE RESONANCE STUDY OF THE SELF-TRAPPED HOLE ASSOCIATED WITH LITHIUM IN NaF. Bass, Isaac L.; Mieher, Robert (Columbia Univ., New York). Phys. Rev. Letters, 15: 25-9(July 5, 1965).

Previous electron spin resonance and electron-nuclear double resonance studies have shown that self-trapped holes ($V_K$ centers) in NaF doped with lithium associate with the Li ions. A study of the lithium $V_{KA}$ center in NaF is presented. The $V_{KA}$ designates the complex consisting of a $V_K$ center associated with an alkali impurity. (M.O.W.)

**33525** THE RELATION BETWEEN MAGNETIC PROPERTIES AND THE SHAPE OF MÖSSBAUER SPECTRA. van der Woude, F.; Dekker, A. J. (Rijksuniversiteit, Groningen, Netherlands). Phys. Status Solidi, 9: 775-86(1965).

The relation between the magnetic properties of a solid and the line shape of its Mössbauer spectrum in the presence of a magnetic hyperfine interaction is studied. In order to observe Zeeman splitting, the natural line width must be smaller than the splitting itself, and the magnetic field at the nucleus must remain constant for a period sufficiently long to allow the nucleus to carry out a Larmor precession of about 1 rad. For paramagnetic materials the latter condition is analyzed in terms of a stationary Markoff spin-flip process; for sufficiently high spin-flip frequencies this leads to "motional narrowing" of the Mössbauer spectrum, in agreement with experimental data. Magnetically ordered systems are treated both by the Weiss molecular field model and the spin wave model. The characteristic features exhibited by the Mössbauer spectra calculated in this way are compared with published data. One important conclusion is that the presence of a pronounced central peak in combination with hyperfine splitting does not necessarily require the coexistence of paramagentic and magnetically ordered regions in the material. (auth)

**33526** INTERACTION OF MAGNETOPLASMA WAVES WITH SPIN WAVES IN A TRANSVERSE MAGNETIC FIELD. Mendelson, K. S.; Spector, H. N. (Illinois Inst. of Tech. Research Inst., Chicago). Phys. Status Solidi, 9: 787-91 (1965).

The interaction of magnetoplasma waves and spin waves in bulk ferromagnetic materials is investigated for the case in which the direction of propagation is perpendicular to the static magnetic induction. For this geometry there are two types of magnetoplasma waves, but only one of them interacts with the spin waves. This one is a transverse plasma wave that propagates at frequencies above the plasma frequency. At wave numbers for which the interaction is a maximum, the modes can not be identified as pure plasma or pure spin waves. The interaction can only be observed in materials in which the plasma frequency is less than the cyclotron frequency. Therefore, the interaction can not be seen in metals, but it might be possible to obtain the interaction in a ferromagnetic semiconductor. (auth)

**33527** VELOCITY DISTRIBUTION OF THE PARTICLES EMITTED BY THE CATHODE SPUTTERING OF GOLD. Beuscher, H.; Kopitzki, K. (Universitat, Bonn). Z. Physik, 184: 382-94(Apr. 15, 1965). (In German)

With Xe and Ar ions with an energy of 25 and 50 kev, polycrystalline gold was bombarded, and the velocity distribution of the particles emitted from the gold target was measured with a rotating selector up to a particle velocity of $4 \times 10^3$ m/sec. With increasing ion energy an increased particle emission in the low-energy range of the spectrum was observed. It possibly depends on an evaporation from thermal spikes, but it can not be described with the simple theory given by Thompson, Nelson, and Farmery. An extrapolation of the velocity spectrum for the bombardment with 50-kev Xe ions to higher velocities yields a velocity of $14.3 \times 10^3$ m/sec, which corresponds to an energy of 200 ev. This energy can be regarded as the focussing energy for the 110 direction of a gold single crystal. (tr-auth)

# REACTOR TECHNOLOGY

## General

*Refer also to abstracts 32449, 32495, and 32680.*

**33528** (CONF-650201(p.257-9)) PUBLIC UNDERSTANDING OF NUCLEAR SAFETY. Southwick, Rodney L. (San Francisco Operations Office, AEC).

A definition of public acceptance of the nuclear industry is offered. The background and some of the extent of AEC informational activities are discussed. The present state of public understanding is described. (D.L.C.)

**33529** (KAPL-M-6464) FLAP—A PHILCO-2000 DIGITAL COMPUTER PROGRAM FLOW, LOOP AND PUMP. Sorenson, C. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 1965. Contract W-31-109-eng-52. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

This program (FORTRAN for 32K Philco S-2000, with a running time of 0.01 hr) computes the total steady state reactor flow and flow through each loop when pump and pressure drop characteristics vary among the loops of a reactor coolant system. It also computes flow patterns with idle pumps and reverse flow in some loops. It can also solve general parallel flow path problems. The method of solution is linear interpolation until the error in flow continuity and pressure rise in each loop are within those specified. Pressure-flow correlations for each individual flow path must be specified in the input data. (auth)

**33530** (RT/ING(64)-10) RELAZIONE DESCRITTIVA DELL'ATTIVITA SVOLTA DALLA DIVISIONE TECNOLOGICA NEL PERIODO LUGLIO 1962–GIUGNO 1963. (Descriptive Report on the Various Activities of the Technical Division for the Period July 1962–June 1963). (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Oct. 1964. 145p. Dep.(mn)

The work of the division is summarized. About 100 papers, which present results of this work in detail, were published during the report period. (J.R.D.)

**33531** INTERRELATION BETWEEN APPRAISAL AND TESTING SCOPE IN THE CASE OF NUCLEAR ENERGY INSTALLATIONS. Coppelt, H. (Technischer Uberwachungs-Verein Bayern e.V., Munich). Atomwirtschaft, 10: 247-8(May 1965). (In German)

The task allotted to the licensing authority for the technical safety assessment of nuclear energy installations consists of two parts: the appraisal and the testing from the technical safety point of view. In the case of appraisal it is a matter of establishing that the installation in question is safe in respect of its total conception and of the design of its individual components. Testing must show in the course of the manufacture of the installation that the technical safety requirements will be met in the case of the completed plant. An optimum solution to the existing technical safety problems can only be reached if appraiser and tester collaborate in as close a way as possible. Only so is it possible to manage the experts' activity with the least expenditure of time and money. (auth)

**33532** A POSITIVE LEAK TEST FOR MAGNOX FUEL ELEMENTS. Hayes, D. J. (Central Electricity Generating Board, Berkeley, Glos, Eng.). J. Nucl. Energy, Pt. A & B, 19: 357-61(May 1965).

A method of testing magnox fuel elements is described, which involves the insertion of a small amount of $^{85}Kr$ into the element before final sealing. Equipment is described which verifies that sufficient $^{85}Kr$ is present in the element and performs a vacuum leak test of high sensitivity. (D.C.W.)

**33533** NEUTRONIC REACTOR OPERATION. Staebler, Ulysses M. (to U. S. Atomic Energy Commission). U. S. Patent 3,193,466. July 6, 1965.

A method is described for resuming reactor operation after shutdown for not more than 72 hours. The reactor is first operated at the average previous power level for one hour, the power of the reactor is then reduced and the reactor is operated at this lower power level for a specified period of time before increasing the power level. (AEC)

## Auxiliaries and Components

*Refer also to abstract 32248.*

**33534** (ORNL-tr-586) SAFETY CONTROL OF NUCLEAR REACTORS. Huston, Norman E.; Hoff, Rodney G.; Wheelock, Clifford W. Translated for Oak Ridge National Lab., Tenn., from German Published Patent Application No. 1,083,948. June 23, 1960. 17p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

A reactor safety control concept is described in which a neutron poison is contained within the reactor core, in a configuration that does not affect the reactivity until a predetermined unsafe condition exists, at which time the poison takes on a form that quickly reduces the reactivity. The method for releasing the poison may be combustion, a heat-sensitive element such as a safety fuse, a pressure differential, mechanically expandable surfaces, or other means. (T.F.H.)

**33535** (ORNL-tr-589) CONTROL RODS AND THE CONNECTING LINKAGES FOR OPERATING THE CONTROL ROD. Thorpe II, Arthur G. Translated for Oak Ridge National Lab., Tenn., from Japanese Patent Publication 19896. Sept. 28, 1963. 10p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

The design of a cruciform control rod having short linkage arms is described. The design includes a centering device that aligns the axes of the rod and linkages, and a constraining device that prevents relative rotation between the rod and linkage. The latter device also aligns the cruciform cross section. (T.F.H.)

**33536** NUCLEAR INSTRUMENTATION FOR REACTOR START-UP REGION. Kaneko, Eiji (Hitachi, Ltd., Tokyo). Hitachi Hyoron, Spec. Issue, 146-54(Nov. 1964). (In Japanese)

The need for extreme safety in reactor operation and for accurate measurement of reactivity over a wide range prompted investigations on the use of semiconductors in nuclear instrumentation. The semiconductor amplifier has a high reliability, compared with the electron tube and requires no cathode heating power, which frequently causes trouble in the electron tube. But the semiconductor still has drawbacks, such as low back-voltage, long switching time, large internal noise, large temperature coefficient, and low input impedance. The all-transistorized system reported, as seen in the specifications given, overcomes many of these drawbacks, providing stabilized high-voltage direct current supplier, HT-26; output range, 500–5000 v; stabilization ratio, $10^{-3}$–$10^{-4}$; dynamic internal resistance, 500 Ω maximum; temperature coefficient, $10^{12}$%/°C; drift, $10^{-3}$%/8hr; pulse-height amplifier for the measurement of neutron fluxes, HT-13; input range, 8 μv–1 mv; band pass frequency, 3 kC–3 Mc; gain, 80 db; logarithmic rate meter, HT-43; range of meters, 0.1 cps–100 kC; input range, −0.1 ~ −14 v; resolution time, 0.6 μsec; response time, 10 msec; drift, 0.1 decade/8 hr; reactor cycle meter, HT-62; meter range, −15 ~ ∞ +3; response time, 0.2 sec. (auth)

**33537** THE DESIGN AND DEVELOPMENT OF IRRADIATION RIGS FOR NON-FISSILE MATERIALS. Nucl. Eng., 10: 182-6(May 1965).

A general treatment is given on the criteria for design and development of irradiation rigs for non-fissile materials. Typical examples of the standard structural mate-

rials rigs, mechanical test rigs, and high-temperature rigs are described. (L.B.S.)

**33538** PROPOSED STANDARD FOR LEAKAGE RATE TESTING OF CONTAINMENT STRUCTURES FOR NUCLEAR REACTORS. Nucl. Eng. Bull., 2: 1-13(Dec. 1964).

A standard was proposed to specify uniform methods for determining the ability of a reactor container to retain, within the limits of permissible leakage rates, any gases, vapors, or liquids, or other fluid materials, which would be of a hazardous nature if not contained and which might be present in the containment structure as a result of an energy release, rupture, or leak in the nuclear reactor components or accessories. The preferred practices and test requirements for quantitative determination of gas leakage rates of containment structures for the housing of operating nuclear reactors are specified. Topics covered include: sequence of tests, general preparations for test pressurizing, time scheduling of the leakage rate test, applicable test methods, test equipment and facilities, the absolute method, the reference vessel method, personnel access to pressurized containment structures, period of test, recording of data, computation of leakage rate, and reinspection and recheck of containment structure. (M.C.G.)

**33539** CLOSED FLUID CIRCULATION SYSTEM FOR REMOVING HEAT FROM A HEAT GENERATOR. Costes, Didier (to Commissariat a l'Energie Atomique). British Patent 993,173. May 26, 1965. Priority date Aug. 23, 1961, France.

A closed fluid circulation system for removing heat from a heat generator, particularly a reactor, includes a number of first headers for a cooling fluid at a temperature lower than the temperature in the heat generator and a number of second headers for the fluid heated in the generator. Fluid flow conduit means within the heat generator connect one first header to one second header. A plurality of heat exchanger means are located outside the heat generator for removing heat from the fluid with means for circulating the fluid located downstream of each of the heat exchangers. Pipes connect each second header through at least one circulating means and one heat exchanger to a first header other than the header connected directly through the generator. (B.L.M.)

**33540** IMPROVEMENTS IN OR RELATING TO APPARATUS FOR LOADING AND UNLOADING NUCLEAR REACTORS. Gerard, Bernard (to Commissariat a l'Energie Atomique). British Patent 993,372. May 26, 1965. Priority date Oct. 20, 1961, France.

A loading and unloading apparatus for fuel elements includes a horizontal rotatable disc-shaped obturator with a vertical axis of rotation. The obturator has two diametrically opposed rectangular apertures: one which serves for the passage of a plug that under normal operating conditions closes an orfice in a cover of the reactor, and a second that serves for the passage of the fuel elements of the core. The apparatus includes two hoods. The auxiliary hood supported on a movable support may be laterally displaced by rotation to permit access to the orifice and is used for withdrawing and holding the closure plug. The main hood comprises a rotatable plug on the lower part and a control mechanism on the upper part for handling tonds movable inside the hood in a channel. The rotatable plug is provided with a rectangular aperture having the same section as the aperture for the passage of the fuel element, and the tongs move in a channel having the same section as this aperture. (B.L.M.)

**33541** COUPLING SYSTEM FOR MECHANICALLY ATTACHING A REFUELLING MACHINE ONTO A NUCLEAR REACTOR CHANNEL. Dejeux, Pol; Clavel, Joseph (to Commissariat a l'Energie Atomique). British Patent 993,648. June 2, 1965. Priority date Sept. 7, 1962, France.

A coupling system is described for mechanically attaching a refuelling machine to a reactor channel that includes a connecting unit mounted on the nose unit of the refuelling machine. The connecting unit comprises a tubular connector adapted to penetrate the end portion of the reactor channel and a sleeve rotatably mounted on the tubular connector. The reactor channel has a stationary ring adjacent to its end portion that provides a bayonet-type locking device with the corresponding end portion of the rotatable sleeve. The connecting unit includes resilient means to permit longitudinal expansion of the connecting unit relative to the refuelling machine and sealing means to provide an autoclave action under operating conditions. Preferrably, the bayonet-type locking device is constituted either by a set of dogs on the outer surface of the sleeve and adapted to engage an equal number of passageways formed inside the stationary ring or by skews formed in the surface of the ring directed towards the reactor channel in such a manner that rotation of the sleeve about its own axis produces mechanical clamping against the stationary ring. The tubular connector is provided at the extremity that penetrates inside the reactor channel with a male spherical surface that co-operates through an intermediary of sealing rings with a female bearing surface formed inside the reactor channel. (B.L.M.)

**33542** A GRAB. Alliot, Paul; Denoit, Daniel (to l'Electricite de France (Service National)). British Patent 994,029. June 2, 1965. Priority date Sept. 18, 1961, France.

A grab for a fuel handling machine is provided that is particularly applicable to gas cooled reactors. The head of the grab is adapted for connection by a suspension cable to a hoist, and a cylindrical member is mounted on the head so as to be capable of axial movement on the head. Claws for gripping the load are pivotally mounted on the cylindrical member. A control cam designed to control the pivotal movement of the claws for gripping and releasing the load comprises eccentric portions uniformly spaced apart and arranged to work in conjunction with one of the ends of the claws. Means are provided for driving a control cam in rotation in dependence of the axial movement of the head with respect to the cylindrical member. The locking of the load in the grab is released only after a predetermined number of contacts on a bearing surface and permits a continuous flow of gas to take place. (B.L.M.)

**33543** ELECTROMECHANICALLY OPERATED GRABS. Loyer, Claude; Mauguen, Pierre; Pinault, Jacques (to Groupement Atomique Alsacienne Atlantique). British Patent 994,134. June 2, 1965. Priority date Dec. 20, 1962, France.

A handling grab is described especially for handling fuel cartridges, yokes, end caps, or similar elements of high-temperature reactors in which the fuel cartridges are stacked in either vertical or horizontal channels. The apparatus includes a grab body, an electromagnet axially supported within the grab body, and one or more groups of grappling tongs. Each group comprises two grappling tongs that are freely mounted within the grab body at the side of the electromagnet. The grappling tongs are made integral with a member of non-magnetic material to which is attached a slightly arcuate flexible spring blade that couples the two tongs together. The application of voltage to the electromagnet has the effect of attracting the tongs and producing a pivotal movement of the tongs as a result of the deformation of the flexible blade. The radial movements of the tongs within the space formed between the grab body and the electromagnet are effected solely as a result of momentary deformation of the coupling blade with all friction eliminated. The mechanical characteristics of the blade are so chosen that when no voltage is applied to the electromagnet the tongs revert automatically to the rest position. (B.L.M.)

**33544** SERVICING APPARATUS FOR GAS COOLED THERMAL REACTORS. Ingram, David John (to General Electric Co.). U. S. Patent 3,168,444. Feb. 2, 1965. Priority date Sept. 27, 1956, Great Britain.

A traveling auxiliary vessel is capable of attachment to the enclosing shell of a pressurized gas-cooled reactor so that the interior conditions of the vessel and the shell may be matched and communication may be made between them through a passage. Separate mechanisms for carrying out

a number of different servicing operations upon the reactor are housed within the vessel and arranged to be brought individually and selectively into operational position above the passage. The apparatus is principally intended for use with reactors with vertical fuel channels and is preferably positioned outside the main biological shield of the reactor. (A.G.W.)

**33545** REACTOR CORE ROD SUPPORT. Leavitt, Stanley L. (to United Aircraft Corp.). U. S. Patent 3,169,098. Feb. 9, 1965. Filed June 12, 1961.

A support for a reactor core rod is designed to assure a supply of cooling fluid to all the cooling passages in the rod without substantial leakage of coolant. The support includes a hollow tube terminating in two coaxial inner and outer sleeve elements integral with the tube and spaced to form an annular chamber between them. The inner sleeve engages a recess in the end of the core rod, and the outer sleeve engages the end of the core rod at its periphery. Coolant flows from the tube into the annular chamber and into the cooling passages in the rod. (A.G.W.)

**33546** SAMPLING APPARATUS. Cashen, William Stephen; Tinkler, Almond (to United Kingdom Atomic Energy Authority). U. S. Patent 3,169,588. Feb. 16, 1965. Priority date Nov. 11, 1959, Great Britain.

A sampling apparatus for obtaining graphite specimens from the wall of reactor channels includes an elongated smooth body and a trepanning head with a cutting face having cutting blades movable into and out from the body. A parting-off cutter is mounted to lie behind the cutting blades during a trepanning cut but can be moved at an appropriate time to make a parting-off cut. A cooling fluid can be fed into the body to pass over the cutting blades. (A.G.W.)

**33547** NUCLEAR REACTOR REFUELLING MACHINE. Hummel, Frederick S. (to Atomic Energy of Canada, Ltd.). U. S. Patent 3,169,909. Feb. 16, 1965. Priority date June 22, 1962, Canada.

A fueling machine for a nuclear reactor includes a snout for clamping on to a flexible projecting end of a reactor tube to form a coaxial continuation of the tube. The snout is mounted on a carriage. Movement of the carriage brings the snout into rough alignment with the tube and causes contact between cooperating guiding surfaces on the snout and the tube. Contact between the snout and the tube activates a device that senses and automatically corrects any displacement of the snout with respect to the tube and thereby effects fine alignment of the snout with the tube. (A.G.W.)

**33548** NUCLEAR REACTOR FUELLING MACHINE. Hummel, Frederick S. (to Atomic Energy of Canada, Ltd.). U. S. Patent 3,169,910. Feb. 16, 1965. Priority date Oct. 10, 1962, Canada.

A refueling machine for a nuclear reactor is provided with means for checking circulation of hot coolant into the fueling machine by causing an auxiliary stream of comparatively cool liquid coolant to flow from each machine into the reactor tube coupled to it. The machines can thus be operated at a substantially lower temperature than the reactor coolant. (A.G.W.)

**33549** NUCLEAR REACTOR CONTROL SYSTEM. Oestreicher, Seymour (to American Machine and Foundry Co.). U. S. Patent 3,170,845. Feb. 23, 1965. Filed Nov. 29, 1961.

A control rod drive mechanism is designed with interchangeable gears and motors of various sizes so that controls can be selectively mounted and arranged in any of several different positions around a reactor core. When the control system is used in a reactor in which the number of fuel elements may be changed such as a swimming pool, the capacity and operating characteristics of the whole system may be changed. (A.G.W.)

**33550** FUEL ELEMENTS FOR VERTICALLY ORIENTED NUCLEAR REACTORS. Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). U. S. Patent 3,170,848. Feb. 23, 1965. Priority date July 19, 1961, Great Britain.

A string of elongated reactor fuel elements superposed to form a column has two flexible tubes extending along the column on opposite sides of the column. A lifting cable passes through one flexible tube, through an end fitting on the bottom fuel element, and through the second flexible tube. After the assembly is charged into a reactor, a release mechanism permits the flexible tube and cable to be withdrawn. Alternatively, a separate cable passes through each flexible tube and connects with the end fitting by remotely releasable means. A stack of fuel elements can thus be charged as a unit and discharged as individual fuel elements. (A.G.W.)

**33551** REACTOR REFUELLING MACHINES. Jones, Jack (to United Kingdom Atomic Energy Authority). U. S. Patent 3,173,844. Mar. 16, 1965. Priority date Nov. 26, 1959, Great Britain.

A reactor refueling machine of the kind traversable across the refueling face of a reactor to connect with a refueling channel is equipped with means for sighting the interior of the channel from a sighting point outside the machine. A beam of light is reflected into the channel, and an optical sighting member receives light rays from the interior of the channel and transmits them along a refracted path toward the external sighting point. The optical sighting member is insertable into and withdrawable from the fuel transfer path along a plane traversing the path. (A.G.W.)

**33552** DEVICE FOR SUPPORTING THE BED OF A NUCLEAR REACTOR WHICH IS COOLED BY A CIRCULATING LIQUID. Chauvin, Michel; Margueron, Jean-Claudius (to Commissariat a l'Energie Atomique). U. S. Patent 3,173,846. Mar. 16, 1965. Priority date Apr. 10, 1961, France.

A device for supporting the bed of a nuclear reactor by the reactor vessel is particularly adapted to liquid-metal cooled reactors. The bed of the reactor rests on an annular and continuous projection of the vessel, but between the bed and the vessel a flexible metal skirt is mounted. The two ends of the skirt are folded one over the other and rigidly secured, one to the bed and the other to the vessel. The metal skirt is pierced with a small number of small holes to produce a series of calibrated outlets for the cooling fluid. (A.G.W.)

**33553** DEVICES FOR DETECTING BREAKS IN FUEL ELEMENT JACKETS IN A NUCLEAR REACTOR. Graftieaux, Jean; Roguin, Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,174,041. Mar. 16, 1965. Priority date May 20, 1960, France.

A device for detecting breaks in fuel element jackets is adapted particularly to monitor an independent experimental loop cooled by a gas stream. The device includes a rotating metallic drum, a positive ion repulsion electrode opposite the periphery of the drum, and a radioactivity detector opposite the periphery of the drum and at a distance from the electrode. The gas stream to be monitored is circulated between the drum and the electrode, ions are collected on an area of the drum, and the drum is rotated so that the collection area is opposite the detector. A calculator connected with the detector gives the concentration of the short-lived fission products, the concentration of the long-lived fission products, and the total activity of the gaseous stream. (A.G.W.)

**33554** SUPPORT STRUCTURE FOR VERTICALLY-STACKED SOLID MODERATOR RODS OF A NUCLEAR REACTOR. Rouge, Pierre (to Commissariat a l'Energie Atomique). U. S. Patent 3,174,906. Mar. 23, 1965. Priority date Apr. 14, 1961, France.

A moderator support structure includes a central element and a series of rigid, independent, concentric, and co-adjacently arranged supporting rings surrounding the central element. The rings are connected by pins arranged in radial slots in such a way that slight relative movement of the rings may occur; the connection is completed on the inner faces of the rings by means of a flexible hermetic junction. Each ring is supported by struts symmetrically arranged around the axis of the stack. One end

of each strut rests on the base of the reactor housing, the other end is connected to a ring. (A.G.W.)

**33555** REACTOR EXCURSION FUSE. Eggen, Donald T.; Morewitz, Harry A. (to North American Aviation, Inc.). U. S. Patent 3,177,124. Apr. 6, 1965. Filed Oct. 31, 1960.

A fuse device for damping on excursion in a reactor operates by separating reactor core components. A foil of $^{235}U$ or other fissile material is incorporated in a severable rod on which layers of moderator, reflector, and/or fuel are stacked. Flat springs between the layers are normally in a compressed state. When a low-melting material holding together the severable rod melts upon heating by the $^{235}U$ during a reactor transient, the rod breaks apart and expands the core components. (A.G.W.)

**33556** SHIELDING ARRANGEMENT FOR A SPHERICAL NUCLEAR REACTOR VESSEL. Benzler, Hartwig (to Babcock and Wilcox, Ltd.). U. S. Patent 3,182,000. May 4, 1965. Priority date Feb. 25, 1960, Germany.

A spherical reactor vessel is shielded by an inner shield positioned between the wall of the vessel and the sides of the core and an outer shield surrounding the vessel. The outer surface of the inner shield has a curved surface conforming to the adjacent vessel wall so that the horizontal cross section of the outer shield is reduced by the amount of the corresponding horizontal cross section of the inner shield. Preferably, the outer surface of the inner shield is convex, and the opposite inner surface of the outer shield is concave. The inner shield is sealed to prevent the infiltration of gases, its outer surface may be cooled, and its inner surface may be clad with a neutron absorbing material. The space between the outside of the reactor core and the inside of the spherical vessel is utilized to accommodate part of the biological shield; thus permitting that part of the shield located outside the vessel to be reduced in the vicinity of the equator of the sphere to reduce the outside dimension of the shield and to slash the over-all cost of the reactor. (B.L.M.)

**33557** MEANS FOR SUPPORTING FUEL ELEMENTS IN A NUCLEAR REACTOR. Thorpe II, Arthur G.; Widmer, Thomas F. (to Westinghouse Electric Corp.). U. S. Patent 3,182,003. May 4, 1965. Filed Apr. 4, 1960.

A grid-like member is provided for supporting fuel elements in a fuel assembly. The grid member is in the form of a plurality of integrated tubular elements. Each tubular element has spring portions so as to support laterally and resiliently each of the fuel elements yet to enable the fuel elements to move axially relative to the grid. The supporting means has a low resistance to coolant flow. (B.L.M.)

**33558** SEALING SYSTEM FOR THE HANDLING HOOD OF A NUCLEAR REACTOR. Chemin, Paul; Lephilibert, Jean (to Commissariat a l'Energie Atomique). U. S. Patent 3,183,162. May 11, 1965. Priority date Oct. 25, 1961, France.

A sealing system is provided between the handling hood of a reactor and a loading channel passing through the reactor cover. A sealing ring is disposed around the top orifice of the loading channel, and resilient means normally support the ring space above the orifice. Sealing means connect the ring and the loading channel. The handling hood includes a passage disposed above the ring and channel to be connected to the channel. The hood is mounted for vertical movement between a first position spaced above the sealing ring and a second position on and in sealed engagement with the ring. In the second position, the hood moves the ring toward the orifice against the action of the resilient means. (B.L.M.)

**33559** DEVICES FOR HANDLING FUEL ELEMENTS IN A NUCLEAR REACTOR. Gumuchian, Andre; Virnot, Alain (to Society Indatom and Compagnie des Ateliers et Forges de la Loire). U. S. Patent 3,183,163. May 11, 1965. Priority date Mar. 23, 1962, France.

An apparatus is provided for handling fuel elements in a reactor with a solid moderator core with vertical access tubes passing through the upper part of a protective caisson that surrounds the core. The apparatus incudes a cable fitted at the end with a handling gripper supporting a frame one portion of which forms a stop for centering the device. A deformable system for guiding the fuel elements is held in a collapsed position inside the frame by the tractive force of the cable. A seat is located beneath the access tubes at the level of the upper ends of the channels and receives the lower part of the frame. A plurality of articulated tubes connected end to end are connected to the frame so that when the frame is seated the tubes move away from the frame and are placed on a selected channel providing a continuous conduit between frame and channel. (B.L.M.)

**33560** REACTOR CONTROL. Evans, Liley A. (to U. S. Atomic Energy Commission). U. S. Patent 3,193,467. July 6, 1965.

Reactor control means comprising a horizontal, V-shaped tube and means for varying the amount of a control solution in the tube are described. (AEC)

**33561** DEVICE FOR COUPLING A CHARGING APPARATUS TO A REACTOR NOZZLE. Ascherl, Robert J.; Hubbard, Eugene T.; Resner, David R.; Oak, Cecil R. (to U. S. Atomic Energy Commission). U. S. Patent 3,195,930. July 20, 1965.

A coupling device is described for attaching to a nuclear reactor a machine for charging the fuel elements. Alignment is accomplished by ring that is adjusted by pneumatic means into sealing engagement after the coupling is connected. (AEC)

**33562** REACTOR MONITORING MEANS. Ohlinger, Leo A. (to U. S. Atomic Energy Commission). U. S. Patent 3,197,377. July 27, 1965.

An arrangement is described for detecting excessive radioactivity in reactor channels. A header that is separate from a regular discharge manifold is connected to the discharge ends of the channels through a plurality of valves, one for each channel, and is provided with a reactivity meter. When the meter indicates excessive radioactivity, the channels are individually monitored through closing of all but one of the valves. There is no interference with regular coolant flow, since the header with which the individual valves and radioactivity meter are associated is separate from the regular discharge manifold. (AEC)

## Criticality Studies

**See also PHYSICS — Criticality Studies.**

*Refer also to abstracts 33190 and 33191.*

**33563** (BNWL-61) ICEDT—AN EXPONENTIAL DATA ANALYSIS CODE. Matsumoto, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 65p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

ICEDT is a comprehensive program for the reduction and analysis of exponential pile data. Geometrical buckling, horizontal or vertical extrapolation, or any combination are available under option. Standard output includes an analysis of the validity of data and aids to the location of possible input errors. Pile dimensions and counter data from horizontal and/or vertical traverses are required for input. Sample data forms and a complete description of input, output, and operation are given in the descriptive document. The symbolic deck consists of about 3000 Fortran and FAP cards. A 32k computer is required. (auth)

**33564** (GA-6283) AN ADIABATIC TREATMENT OF THE XENON PROBLEM. Scalettar, Richard (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Apr. 2, 1965. Contract AT(04-3)-167. 29p. (CONF-650413-4). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on Neutron Dynamics and Control, Tucson, Ariz.

An adiabatic treatment of time-dependent reactor problems is presented, emphasizing the formal characteristics of the treatment for the cases in which the "Hamiltonian" is a functional of functions of position and time. (T.F.H.)

**33565** (ORNL-P-140) EFFECT OF FLOOR-REFLECTED NEUTRONS ON ROSSI-$\alpha$ MEASUREMENTS WITH THE HEALTH PHYSICS RESEARCH REACTOR. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). [July 2, 1964]. Contract W-7405-eng-26. 9p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Rossi-$\alpha$ measurements of the prompt-neutron decay constant of HPRR are carried out, with HPRR suspended near the center of a 70 × 30 × 50 ft building. The sensitivity of the Rossi-$\alpha$ measurements to floor-reflected neutrons is studied by placing a 64 × 64 × 8 in. slab of concrete blocks on the floor underneath the reactor. It is concluded that the prompt-neutron decay constant measured by the Rossi-$\alpha$ method in bare reactors is insensitive to the presence of materials farther than about 1 ft from the core surface if these materials do not affect the reactivity of the reactor by more than 30¢. (T.F.H.)

**33566** (ORNL-P-1235) COMPUTATIONAL PROBLEMS OF REACTOR SAFETY. Ergen, W. K. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 13p. (CONF-650501-10). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From the Application of Computing Methods to Reactor Problems, Argonne, Ill.

A descriptive outline is presented of the uses of computers in reactor safety calculations. Computer uses in reactor dynamics, Doppler-effect, reactivity, hydraulic, thermal-mechanical, fission-fragment transport, and meteorological computations are outlined. (T.F.H.)

**33567** (TID-20263) THE USE OF SUBCRITICAL ASSEMBLIES FOR STUDYING REACTOR PARAMETERS. Bach, D. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 12p. (CONF-640104-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Cornell Univ. Colloquium, Ithaca, N. Y.

Experimental studies of neutron decay characteristics of far-subcritical (reactivity less than 0.80) assemblies are reported. The results are compared with diffusion-theoretical calculations. The usefulness of the experimental techniques used, as applied to the analysis of reactor characteristics, is discussed. (T.F.H.)

**33568** (TID-21860) MEASUREMENT OF REACTOR SHUTDOWN MARGIN BY CORRELATION TECHNIQUES. [Final Report]. Uhrig, Robert E. (Florida Univ., Gainesville. Dept. of Nuclear Engineering). May 1965. Contract AT(40-1)-3067. 392p. Dep.(mn); $7.00(cy), 7(mn) CFSTI.

An analysis is given of the use of correlation techniques, in which naturally occurring or induced fluctuations in reactors are analyzed, to measure the shutdown reactivity of reactors. (T.F.H.)

**33569** (WAPD-T-1762) A SYSTEM FOR NUCLEAR REACTOR DEPLETION COMPUTATION. Breen, R. J.; Marlowe, O. J.; Pfeifer, C. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1965. Contract AT-11-1-GEN-14. 20p. (CONF-650501-11). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From the Application of Computing Methods to Reactor Problems, Argonne, Ill.

A reactor-fuel depletion system (HARMONY) is described that can be used with few-group diffusion-theory programs. The depletion system can be tailored to fit the reactor properties. No explicit limit is set on the number of depletable nuclides that can be represented. (T.F.H.)

**33570** CONTRIBUTIONS TO THE STUDY OF NUCLEAR REACTOR KINETICS AND METHODS FOR THE MEASUREMENT OF NEGATIVE REACTIVITY. Sani, L.; Zanchi, F. Energia Elettrica, 40: 310-21(1963). (In Italian)

Dynamics of nuclear reactors with various burnup reactivity were studied by inserting a neutron source. The simulated conditions were analogous to the various possible conditions of reactor functions. An analysis of reactor response was studied by perturbation dynamics considering some methods for measuring negative reactivity using control rod positions and the value $k_{eff}$ of the subcritical assembly. (tr-auth)

**33571** COEFFICIENTS OF AIR PRESSURE IN REACTIVITY MEASUREMENTS OF GAS COOLED NUCLEAR REACTORS. Lesnoni, G. (ENEL, Rome); Sani, L. Energia Elettrica, 40: 825-9(1963). (In Italian)

Coefficients of air pressure in reactivity measurements of gas cooled nuclear reactors were studied using air as poison for calibration of control rods in gas-graphite reactors. It is shown that pressure coefficient of reactivity absorbed by air can be independent of air pressure. Changing core configuration pressure coefficient follows nearby linear law of dependence on balancing pressure; experimental graphs of Latina reactor are presented. (auth)

**33572** GENERALIZATION OF GALANIN METHOD FOR TREATMENT OF NUCLEAR REACTOR LATTICES CONTAINING FUEL CHANNELS. Amin, M. (West Pakistan Univ. of Engineering and Tech., Lahore). J. Nat. Sci. and Math., 4: 75-88(Oct. 1964).

The Galanin method is generalized for the treatment of 2-dimensional practical reactor lattices which have fuel elements of finite radii resting in coolant channels. Expressions are derived for thermal utilization and flux in the case of rectangular, square, rhombic, and equilateral triangular cell lattices, which hold exactly for fuel channels of all radii. Numerical computations are performed for the excess absorption term for typical heavy water, graphite, and light water moderated assemblies with various cell shapes and compared with those performed by Neumann. The feasibility of application of the generalized Galanin method to reactor lattices, having various cell shaped and weakly and non-weakly absorbing moderators, is established. (L.B.S.)

**33573** COMPARISON OF LATTICE PHYSICS EXPERIMENTS IN HEATED GRAPHITE STACKS CONTAINING PLUTONIUM–URANIUM FUEL WITH THEORETICAL PREDICTION. Gibson, M.; Harper, R. G. (Atomic Energy Establishment, Winfrith, Dorset, Eng.). J. Nucl. Energy, Pt. A & B, 19: 343-56(May 1965).

Measurements of buckling and flux fine structure and fission-rate distributions in graphite-moderated lattices fuelled with plutonium–uranium metal rods at temperatures up to 400°C are summarized. The results are of general interest in the development of rigorous methods of calculation for plutonium-bearing systems. The measured values are compared with theoretical calculations which determine a detailed representation of the neutron energy spectrum and incorporate fundamental nuclear data libraries. There is general overall agreement between the measured values and the theoretical predictions. (auth)

**33574** THE MEASUREMENT OF REACTIVITY IN MULTIREGION SUBCRITICAL SYSTEMS BY THE PULSED NEUTRON TECHNIQUE. Sherwin, J.; Leng, J. H. (United Kingdom Atomic Energy Authority, Sellafield, Cumb, Eng.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/25, 37p. (CONF-650504-31)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The prompt decay of a thermalized burst of neutrons in a multiregion subcritical system is examined using a two-group diffusion theory. It is shown that a relation can be established between the prompt decay constant of the fundamental mode and the effective multiplication factor of the system in terms of two parameters defined as the reactor response coefficient and the prompt decay correction and which depend to a large extent on the spatial flux patterns within the system. For the uniform bare system, the response coefficient can be identified with the mean neutron lifetime in the system; for a multiregion system it

represents a compound of the lifetimes in each region weighted by perturbation type integrals. The second parameter, the decay correction, can have no physical meaning in that it arises from an attempt to relate the two scales of reactivity involved; that is the scale using the prompt decay constant and the scale derived using the effective multiplication factor. The properties of these parameters are examined here with reference to an enriched-uranium, graphite-moderated reactor consisting of a uniform core and reflector, and it is shown that the two parameters are not uniquely defined by the reactivity of the system, but depend on the method chosen to make the system subcritical. Two sets of measurements are treated by the theory. In one, the Windscale Advanced Gas-Cooled Reactor was shut down by a uniform poison. In the other, the reactivity of a core in the zero-energy reactor HERO was varied by altering the loaded radius. The neutron pulse measurements are all shown to be in good agreement with more conventional methods of reactivity determination. Some discussion of the experimental techniques and the difficulties encountered in the graphite-moderated systems is presented. (auth)

## Design and Feasibility

**33575** (AP-Note-444) REACTORS WITH MIXED NATURAL AND HIGHLY ENRICHED URANIUM. Murray, Raymond L. (Alco Products, Inc., Schenectady, N. Y. Nuclear Power Engineering Dept.). July 6, 1962. Contract AT(30-1)-2639. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A preliminary investigation is made of the feasibility of employing a composite of natural $UO_2$ pins and highly enriched $^{235}U$-stainless steel plates of the SM-2 type in a water-moderated reactor. The advantage of natural uranium as a fuel is its low cost; the virtue of the plates is that they have been shown to be able to withstand a high burnup fraction. It has been proposed that a suitable choice of the relative volume fractions of two standard fuel configurations could lead to significant improvements in reactor economy. The regions of possible interest and trends in size and multiplication factor with the degree of enrichment are studied. (auth)

**33576** IMPROVEMENTS IN NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain S. A.). British Patent 993,867. June 2, 1965. Priority date May 24, 1961, Belgium.

A reactor is designed in which a moderator space in the core defines a moderator chamber filled with a first moderator fluid, heavy water. An expansible member in the moderator chamber is filled with a second moderator fluid, light water. During operation the reactor is controlled by varying the respective volumes of both moderator fluids by changing the pressure of the second fluid to expand or contract the expansible member. The second moderator fluid may contain a poison. (B.L.M.)

**33577** BOILING WATER REACTOR WITH INTEGRAL STEAM SUPERHEATING. Kluge, Hans; Fischer, Erhard (to Licentia Patent-Verwaltungs GmbH). German Patent 1,183,605. Dec. 17, 1964. Filed Feb. 12, 1960.

The boiling water reactor provided includes a reactor vessel, a transverse core supporting matrix plate from which a plurality of parallel, open-ended nuclear fuel containing process tubes extend downward, and a steam plenum extending upward from the core supporting matrix plate. The water flows upward through the fuel containing process tubes, cools the fuel elements, and thereby becomes vaporized and superheated. The superheated steam flows into the plenum and from there through the coolant outlet. A body of water having a free upper liquid level situated above the steam plenum is maintained around the tubes and the steam plenum, so that a steam cushion is formed in the cavity between the free level of the water and the top of the reactor vessel. (Gmelin Inst.)

**33578** PRESSURE VESSEL FOR A NUCLEAR REACTOR. Challender, Ronald Scott; Griffiths, Jack Jones (to United Kingdom Atomic Energy Authority). U. S. Patent 3,171,790; Mar. 2, 1965. Priority date Oct. 22, 1959, Great Britain.

A method for attachment of branch pipes to pressure vessels is described, such that the axis of the cylindrical surface of contact between the branch pipe and vessel makes a greater branch angle with the tangential plane of the vessel at the point of attachment than that made by the axis of the bore of the branch pipe with the same tangential plane. The method is used in designing a reactor having a moderator support within the pressure vessel connected by tie rods extending through branch pipes to a support structure above the reactor pressure vessel. (A.G.W.)

**33579** HETEROGENEOUS NUCLEAR REACTOR. Kumpf, Hermann (to Siemens-Schuckertwerke AG). U. S. Patent 3,182,001. May 4, 1965. Priority date July 23, 1959, Germany.

A heterogeneous reactor includes a reactor tank having a grid structure of parallel coolant channels for receiving fuel elements. The moderator space surrounds the channels and is defined by the fuel bearing portions of the channels. A portion of the moderator space, preferably in the central grid or core zone portion, is separated from the rest of the moderator space by a partitioning wall structure. The partitioned-off portion is connected into the coolant circulation system at a hot location of the system and is traversed by the coolant in a heated condition. The volumetric proportion of the temperature-dependent coolant in the grid zone is increased, and the effect of density variation due to reactivity excursions is intensified thus achieving a self-stabilization of the reactor. (B.L.M.)

**33580** NUCLEAR REACTOR. Bell, Alan (to Foster Wheeler Corp.). U. S. Patent 3,183,168. May 11, 1965. Filed Jan. 31, 1962.

A heterogeneous reactor includes a pressure vessel with a horizontal sheet disposed across the vessel at the upper end dividing the vessel into an upper plenum chamber and a lower main chamber. The main chamber contains a body of moderator and a plurality of spaced coaxial tube pairs suspended in the moderator. The tubes are spaced from each other to define an annulus surrounding the inner tube of the pair. The outer tube is carried on and depends from the horizontal sheet and extends into the main chamber in fluid communication with it. The inner tube passes through the plenum chamber through the upper end of the pressure vessel and is suspended from the pressure vessel. Cooling fluid is admitted into the plenum chamber and flows through the annuli of the tube pairs. The inner tubes of the pairs contain fuel elements and are open at the lower end in fluid communication with the annuli to receive the cooling fluid. The moderator is maintained at a pressure and temperature substantially equal to that of the cooling fluid entering the plenum chamber. (B.L.M.)

## Fuels

**33581** (CEA-R-2795(Vol.II)) ETUDE DES VALEURS ET DES PRIX DU PLUTONIUM A LONG TERME—UN MODELE PARAMETRE SIMPLIFIE. VOLUME II. DEVELOPPEMENT DU MODELE PARAMETRE SIMPLIFIE ET APPLICATION—ANNEXES. (Study of the Long-Term Values and Prices of Plutonium—A Simplified Parametrized Model. Volume II. Mathematical Development of the Simplified Parametrized Model and Application—Appendices). Gaussens, Jacques; Paillot, Henri (Commissariat a l'Energie Atomique, Paris (France)). May 1965. 135p. Dep.(mn).

Definitions are given of the notions of use values and price of plutonium. A "simplified parametrized model" is given simulating the equilibrium of the offer and the demand in time, concerning the plutonium and the price deriving from the relative scarcity of this metal, taking into account the technical and economic operating parameters of the various reactors confronted. This model is simple enough to allow direct computations and establish

clear relations between the various parameters. The use of the linear programmes method allows on the other hand a wide extension of the model. This report includes the mathematical development of the simplified parametrized model and application (the basic data and the results of the calculations are given), and appendices giving the detailed computations. (auth)

**33582** RESEARCH OF THE PISA ENGINEERING FACULTY ON THE THERMOELASTOPLASTIC STABILITY OF LAMINAR FUEL ELEMENTS. Guerrini, Bruno (Universita, Pisa, Italy). Riv. Ing. Nucl., 2: 595-608(Nov.-Dec. 1964). (In Italian)

In fuel elements consisting of thin, flat sheets temperature distributions of different forms are developed because of the nonuniform distribution of the fissile material and the neutron flux. This causes stress states in the fuel elements. As a result of the stress state with increase of the temperature there is first increase of the geometric irregularity, of technological origin, of the laminar fuel elements and then instability phenomena of the thermoelastoplastic equilibrium of the fuel element with consequent formation of blisters and significant modifications of the channels for the coolant. The preliminary results of a theoretical and experimental study of this phenomenon were reported. (tr-auth)

**33583** FUEL ELEMENT FOR NUCLEAR REACTOR. Harde, Rudolf; Rische, Ernst; Brandstetter, Amandus; Stoehr, Karl Walter (to INTERATOM). German Patent 1,187,332. Feb. 18, 1965. Filed Sept. 16, 1960.

A nuclear fuel element assembly is designed in which a plurality of fuel rods is contained within a tubular casing. The fuel rods are disposed parallel and in spaced relation to one another. Each of the casings is provided with openings for the circulation of a cooling medium through them. The fuel rods extend between two blocks with the ends fitting into seats in the blocks. In order to provide a solid reflector rods of metallic hydride are disposed within the casing by fitting them into the seats in the blocks in such a way that they surround the fuel rod bundle. (Gmelin Inst.)

**33584** FUEL ELEMENT END CLOSURE ASSEMBLY. Meyers, Gilbert W. (to Babcock and Wilcox Co.). U. S. Patent 3,169,097. Feb. 9, 1965. Filed Mar. 25, 1959.

An end closure for a rectangular tubular fuel element container has a hollow reinforcing member located within and at the extremities of the container. The shape of the outer surface of the reinforcing member conforms to the internal surface of the tubular container. The internal surface is cylindrical and concentric with the longitudinal axis of the container. A cylindrical nozzle is positioned within the reinforcing member and is removably attached to both the reinforcing member and the fuel element container. Both the reinforcement and fuel elements may thus be removed without damaging the container. (A.G.W.)

**33585** PLATE-TYPE NUCLEAR FUEL ELEMENTS. Simpson, Philip Ross (to United Kingdom Atomic Energy Authority). U. S. Patent 3,173,843. Mar. 16, 1965. Priority date Oct. 24, 1958, Great Britain.

A plate-type fuel element consists of a series of arcuate fuel plates secured along their edges to transverse supports so as to form a series of connected spaced concentric fuel tubes. The supports form continuous heat conducting paths from the inner to the outer concentric tubes. (A.G.W.)

**33586** FUEL ELEMENTS FOR NUCLEAR REACTORS. Ritz, Heinrich Hugo Ludolf (to C. A. Parsons and Co. Ltd.). U. S. Patent 3,173,845. Mar. 16, 1965. Priority date May 21, 1957, Great Britain.

A fuel element for a nuclear reactor consists of plates containing nuclear fuel so arranged that, when the element is in position in the reactor cooling channel, they are inclined to the longitudinal axis of the channel. The dimensions and the spacing of the plates are such that a cooling fluid can flow in the direction of the lontitudinal axis of the channel and between the plates. The plates may be held in place by two pillars, each end of a plate being attached to a pillar, or they may be located in a tube, each plate being attached to the tube. (A.G.W.)

**33587** FUEL ROD FOR NUCLEAR REACTORS. Huet, Andre. U. S. Patent 3,177,123. Apr. 6, 1965. Priority date May 13, 1959, France.

A tubular fuel element has transverse channels in the body of the tube, which are intended to provide for the passage of cooling and/or moderator fluid from the exterior of the tube to the axial channel inside the tube. The channels are preferably of helicoidal form and open into the axial channel tangentially to the inner wall of the tube so as to impart a helicoidal movement to the fluid. Either the tube itself or the axial channel or both may be of frustoconical shape. (A.G.W.)

## Power and Power-Breeder Reactors

*Refer also to abstracts 32359 and 32777.*

**33588** (ANL-7020(p.238-55)) STUDIES AND EVALUATIONS. (Argonne National Lab., Ill.).

A cost evaluation is made of power generation by a 1000-Mw(e) reference metal-fueled fast breeder reactor. A reference compact pyrochemical process for fuel reprocessing is described. Fuel cycle costs are estimated. The costs of reprocessing of fast reactor plutonium fuels are compared for alternative processing methods. Shipping and inventory costs are included. (D.L.C.)

**33589** (AP-Note-364) SUMMARY OF SM-1 PHYSICS MEASUREMENTS THROUGH END OF CORE LIFE. Weiss, S. H.; Kemp, S. N.; Schrader, E. W.; Moote, F. G. (Alco Products, Inc., Schenectady, N. Y. Nuclear Power Engineering Dept.). Contract AT(30-1)-2639. 16p. (CONF-587-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society 1961 Annual Meeting, Pittsburgh, June 1961.

Experimental methods, analytic techniques, and obtained values are presented for physics measurements during SM-1 Core I lifetime. (T.F.H.)

**33590** (BNWL-28) ECONOMIC EVALUATION OF CLOSE-COUPLED FUEL PROCESSING WITH PLUTONIUM RECYCLE. McKee, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT(45-1)-1830. 76p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A study was made of the relative fuel cycle costs of two alternative reactor fuel cycles employing light water-moderated reactors and reprocessing-refabrication either at a large central plant or at a small plant nearby (close-coupled). Three reactor types and two fuel management concepts (several reactors at one site with staggered fuel discharges, and a single reactor with 1-yr discharges) were considered, and the results are interpreted in terms of 1000-Mw(e) reactor capacity. It was found that fuel exposure for a close-coupled plant cycle optimizes at 15,000 to 20,000 Mwd/t, and that a $6.2 million close-coupled plant serving a 1000-Mw(e) reactor complex can be competitive with central plant processing. (D.L.C.)

**33591** (CONF-640507(p.209-12)) AUTOMATIC EXIT STEAM QUALITY CONTROL FOR BOILING WATER REACTORS. Gall, D. A.; Doyle, E. F.; Rohsenow, W. M. (Dynatech Corp., Cambridge, Mass.).

A device for maintaining a constant exit steam quality is described, and some test results are described. The transient response of the device to a 25% power change in a 1000-psi steam–water loop is described. The application of the device to a boiling reactor is considered briefly. (D.L.C.)

**33592** (CONF-640507(p.311-16)) RESEARCH PROGRAM ON BOILING WATER REACTOR DYNAMICS. Kirchenmayer, A. (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main (West Germany)).

The need for an analytical model to describe the dynamic behavior of boiling reactors is pointed out. Some of the assumptions used in such a model are discussed. The agreement between the calculated and measured transfer functions of EBWR is discussed. The loop and program for transfer function measurements are discussed briefly. (D.L.C.)

**33593** (CONF-650201(p.35-44)) THE REACTOR LICENSING PROCESS. Lowenstein, Robert (Atomic Energy Commission, Washington, D. C.).

The development and background of the AEC regulatory process are reviewed. The stages in the licensing of power reactors are outlined, and the phases in the construction permit stage are discussed in some detail. Informal safety reviews of commercial reactor systems or components are also considered. The factors which complicate the regulatory process are described. (D.L.C.)

**33594** (CONF-650201(p.98-101)) SITING OF NUCLEAR PLANTS NEAR POPULATION CENTERS. Koffmann, E. (Department of Water and Power of the City of Los Angeles, Calif.).

The engineered safeguards proposed at the San Onofre, Connecticut Yankee, and Malibu nuclear plants are examined, and their effect on the distance requirements as given in TID-14844 is determined. (D.L.C.)

**33595** (CONF-650201(p.102-9)) REMOTE SITING OF NUCLEAR POWER PLANTS. Stoller, Sidney M. (Stoller (S.M.) Associates, New York).

The results of a 1962 study on the cost penalty of the AEC reactor siting criteria in the utility market are reviewed and updated. The more rapid growth of nuclear power adds to the problem of the restrictive effects of the siting criteria, although engineered safeguards and the trend toward remote location of fossil plants alleviates the problem. Some thoughts are offered on this problem and on how to solve it. (D.L.C.)

**33596** (CONF-650201(p.110-24)) INFLUENCE OF SAFETY PROBLEMS ON THE DEVELOPMENT OF ECONOMIC NUCLEAR POWER. Vann, Harold E. (Jackson and Moreland, Boston, Mass.).

A discussion is presented of the economic status of nuclear plants, the cost associated with reactor safety, the effects of siting on plant cost, and the economic risk in constructing nuclear plants. The most favorable economics are obtained when the nuclear plants are located at the load centers, and there are insufficient sites available for a wide-scale development of nuclear power unless these plants can be safely located near populous areas. (D.L.C.)

**33597** (CONF-650201(p.247-53)) PUBLIC ACCEPTANCE OF NUCLEAR POWER. Stroube, Hal (Pacific Gas and Electric Co., San Francisco, Calif.).

The Bodega project and its subsequent cancellation are discussed with reference to the public relations problem in the nuclear power industry. It is felt that the problem would be helped if scare words (scram, poison, criticality, etc.) and acronyms were discarded, and the updating of the WASH-740 report were dropped. The importance of winning the confidence of the press is emphasized, and this cannot be done except with complete honesty and sincerity. The education and information of the public is shown to be crucial to the future development of nuclear power. (D.L.C.)

**33598** (CONF-650201(p.260-9)) PUBLIC ACCEPTANCE OF NUCLEAR POWER AS RELATED TO THE FERMI PLANT. Wagner, H. A. (Detroit Edison Co., Mich.).

A brief discussion is given of the approach and experiences in developing public acceptance of the Enrico Fermi Atomic Power Plant. The public information program was started before, and continued throughout, the plant construction. Some of the literature and exhibits used are described. (D.L.C.)

**33599** (CONF-650201(p.277-87)) REACTOR SITING. Hosmer, Craig (American Nuclear Society, Los Angeles, Calif.).

It is pointed out that political and psychological considerations frequently are dominant in electric utility decisions on the construction of nuclear power plants. The development of the safety review process and the regulatory process is described. Some specific reactor licensing cases and insurance aspects are discussed. Reactor safety research and site criteria are discussed, and the opposition to siting of reactors is considered. (D.L.C.)

**33600** (CONF-650201(p.288-92)) THE INFLUENCE OF REACTOR SITING POLICIES ON THE PROGRESS OF THE CIVILIAN NUCLEAR POWER PROGRAM. Pittman, Frank K. ([Division of Reactor Development (AEC), Washington, D. C.]).

The public sentiment for the preservation and beautification of land is considered briefly. It is contended that the present AEC safety analysis procedures, with their emphasis on siting and the "Maximum Credible Accident," may hamper the future growth of the nuclear power industry unless they are changed. The importance of considering all safety problems, rather than just the Maximum Credible Accident, is emphasized. Incentives should be given for designing reactors with a vanishingly small probability of any accident, rather than for installing numerous engineered safeguards. (D.L.C.)

**33601** (DP-965) HEAVY WATER MODERATED POWER REACTORS. Progress Report, January–February 1965. Hood, R. R., comp. (Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Technical Div.). Mar. 1965. Contract AT(07-2)-1. 27p. Dep.; $2.00(cy), 1(mn) CFSTI.

The Heavy Water Components Test Reactor (HWCTR) was placed in standby condition upon termination of the development program on $D_2O$-cooled power reactors. An experimental program was proposed for development of metallic-U fuel elements for $D_2O$-moderated organic-cooled reactors. An experimental study was made of the stability of boiling water flow in long coolant channels in parallel, simulating the channels of a nested-tube fuel assembly. Flow instabilities occurred at lower heat fluxes than burnout when three 6-ft-long electrically heated tubes were operated in parallel with boiling flow at 500, 1000, and 1500 psia. (auth)

**33602** (GA-6146) HTGR FUEL CYCLE ASSESSMENT STUDIES. Stewart, H. B.; Jaye, S.; Traylor, R.C. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). May 11, 1965. Contract AT (04-3)-167. 46p. (CONF-650606-6). Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

From EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels.

Medium- and long-range economic and feasibility studies for nuclear power are outlined, and the role of the high-temperature gas-cooled reactor is analyzed within this context. (T.F.H.)

**33603** (GEAP-4816) HIGH POWER DENSITY DEVELOPMENT PROJECT. Nineteenth Quarterly Progress Report, October 1964–February 1965. Holladay, R. L. (comp.) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1, 1965. Contract AT (04-3)-361. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

An examination of a failed fuel rod containing low-density (86% of theoretical) vibratory compacted powder $UO_2$ fuel with a peak fuel burnup of about 7000 MWD/TU was performed. There was no evidence of dimensional change or visibly detectable loss of $UO_2$ fuel, but there was extensive sintering of the fuel particles and minor oxidation of the $UO_2$ near the cladding failures. The change in the microhardness of both initially annealed and cold worked type 304 stainless steel was measured as a function of fast neutron exposure. Electron microscopy of irradiated type 304 stainless steel cladding from several HPD fuel rods was performed. There was no evidence of carbide precipitation or phase transformations at grain boundaries. Fast neutron irradiation to ~$10^{21}$ nvt >1 Mev at 625°F resulted in no microstructural changes other than an increased concentration of black dots which could sometimes be resolved into dislocation loops surrounding disks

of precipitated vacancies or interstitials. Measurements of in-core power and flow were made with an instrumented fuel assembly during the full-power Phase II tests. The data and some preliminary observations are presented. Fuel placement and control rod patterns to allow full power operation at 75 MW$_t$ for a period of 4 to 6 months were specified for an 84-bundle core at Big Rock Point. (W.L.G.)

**33604** (HPR-57) HBWR QUARTERLY PROGRESS REPORT, JULY–SEPTEMBER 1964. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1964. 138p. Dep.(mn)

Plant operation, performance and engineering are summarized along with research and development activities. (J.R.D.)

**33605** (MND-2706-14) TUBULAR CORE DEVELOPMENT PROGRAM — PM CORE 3 DESIGN STATUS REPORT. Brittain, W.; George, T.; Christenbury, C.; Pollard, J.; Rosenthal, H.; Russo, F.; Smith, C.; Trushin, J. (Martin Co., Baltimore, Md. Nuclear Div.). Jan. 1965. Contract AT(30-1)-2706. 451p. Dep.(mn); $7.51(cy), 7(mn) CFSTI.

The status of the PM Core 3 mechanical, nuclear, and thermal-hydraulic design is reported. The results and analyses of critical experiments and thermal-hydraulic tests performed in support of Core 3 design are reviewed. Core 3 incorporates stainless-steel-$UO_2$ cermet fuel tubes clad on both sides with type 347 stainless steel; burnable poison elements of $B_4C$ dispersed in Zircaloy-2; finger-type control elements; and one neutron source tube. (T.F.H.)

**33606** (MND-3297-9) PM CORE-2 UPRATING STUDY. MAXIMUM POWER CAPABILITY OF PM CORE 2. Final Report. Trushin, J. T.; Brittain, W. M.; George, C.; Guenther, E.; Russo, F. (Martin Co., Baltimore, Md. Nuclear Div.). Dec. 1964. Contract AT(30-1)-3297. 274p. Dep.(mn); $6.00(cy), 5(mn) CFSTI.

System operating parameters are varied in the PM core 2, in order to define the maximum permissible operating power capabilities of this core. The parameters varied include primary coolant pressure, flow rate, and core inlet temperature. Mechanical, nuclear, and thermal limitations on core 2 power are established and correlated. Tabular and graphical data are then presented, which define a core performance profile and a core power-limitation profile. (T.F.H.)

**33607** (NAA-SR-Memo-11135) FUEL ELEMENT DESIGN, ANALYSES, SPECIFICATIONS, AND EXAMINATION PROCEDURES FOR THE HWOCR EXP-NRU-305 EXPERIMENTS. Frank, J. E.; Hahn, R. D.; Olson, P. S. (Atomics International, Canoga Park, Calif.). Mar. 9, 1965. Contract AT-11-1-GEN-8. 33p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The design of a UC fuel element to operate at 21 kw/ft at a centerline temperature of 2000°F to burnups equal to or greater than 10,000 Mwd/MTU is presented. Fuel preirradiation data requirements, specifications, schedules, and post-irradiation examination procedures for the proposed experiment are included. (auth)

**33608** (ORO-586(Vol.I)(Suppl.I)) REVISIONS TO EXPERIMENTAL GAS COOLED REACTOR FINAL HAZARDS SUMMARY REPORT, OCTOBER 10, 1962. VOLUME I. DESCRIPTION AND HAZARDS EVALUATION. (Oak Ridge Operations Office (AEC), Tenn.). Apr. 1965. 366p. Dep.; $5.00(cy), 4(mn) CFSTI.

Revision sheets for the final hazards summary report for EGCR are given. Only revised pages are included. (T.F.H.)

**33609** (TID-21861) HALLAM NUCLEAR POWER FACILITY MONTHLY OPERATING REPORT NO. 32, MARCH 1965. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 77p. Dep. (mn); $3.00(cy), 2(mn) CFSTI.

A summary of plant operating history is presented along with summaries of plant operation and performance during the report period. Summaries are also included on plant testing, maintenance, modifications, moderator transfers, core transfers, radiation control, and operating procedure additions. (J.R.D.)

**33610** (TID-21893) HALLAM NUCLEAR POWER FACILITY MONTHLY OPERATING REPORT NO. 31, FEBRUARY 1965. (Consumers Public Power District, Hallam, Nebr.) Contract AT(11-1)-513. 79p. Dep. (mn); $3.00(cy), 2(mn) CFSTI.

A summary of plant operating history is presented along with summaries of plant operation and performance during the report period. Summaries are also included on testing, maintenance, modification, radiation control, moderator replacement, core transfers, and operating procedure additions. (J.R.D.)

**33611** (WAPD-T-1684) A STOCHASTIC MODEL OF XENON FORMATION IN A NUCLEAR POWER REACTOR (thesis). Prescop, Val (Pittsburgh Univ., Pa.). 1965. Contract AT(11-1)-Gen-14. 62p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The power reactor, considered as a stochastic system with feedback, is analyzed. The analysis is not found to modify the deterministic model, except near the marginal stability point of the deterministic model. The stochastic model indicates that the iodine-xenon feedback process alone as a control means is inherently unstable. The measures of control necessary for stationarity are found to be equal in the deterministic and stochastic models. The characteristics and practicality of the stochastic method are discussed. (T.F.H.)

**33612** NUCLEAR POWER STATION. Guck, R. W. (Abteilungsdirektor der Badenwerk AG, Karlsruhe, Ger.). Brennstoff-Waerme-Kraft, 17: 133-8(Mar. 1965). (In German)

The most significant aspects of the papers on nuclear power plants presented at the Lausanne Conference are summarized. The classification of nuclear power plants, the fuel cycle, improvement of the thermodynamic efficiency, construction and operational problems, and heavy-water moderated reactors were considered. (J.S.R.)

**33613** NEXT FOR CANDU: DIRECT CYCLE STEAM? Can. Chem. Process., 48: No. 10, 57-8; 60; 74(Oct. 1964).

The efforts and interest at Chalk River in the development of a heavy-water-moderated reactor using light water in the form of wet steam as the coolant are summarized. The development of a suitable fuel (a natural U–Zr alloy seems most probable) is considered, and the costs for this reactor concept are compared with those for similar reactors fueled with $UO_2$ and for a heavy-water-cooled reactor fueled with $UO_2$. (D.C.W.)

**33614** QUEBEC WILL GET CANDU-BLW REACTOR. Can. Chem. Process., 49: 57-8; 61-2(May 1965).

The boiling light-water reactor to be built in Quebec is briefly discussed, including the new fuel geometry. The design bases for the reactor are summarized, and cost estimates and design characteristics for a 500-Mwe unit are given. The costs of three sizes of boiling light-water reactors are compared with those for pressurized heavy-water reactors of corresponding sizes. (D.C.W.)

**33615** 500 MW NUCLEAR STATIONS ON LOAD. Elec. Export Rev., 4: 37-8(Apr.-June 1965).

In February 1965 the No. 1 reactors at the Central Electricity Generating Board's nuclear power stations at Hinkley Point (Somerset, England) and Trawsfynydd (North Wales) were commissioned and the stations became the first of their type and size in the world to deliver electricity to a supply system. The No. 2 reactors at both stations were expected to be commissioned by early May. Each reactor is of the magnox type and has a design capacity of 250 Mw. Some of the many technological problems encountered in the reactors are reviewed. Three other nuclear power stations built for supply authorities are in operation in Britain: Berkeley, 275 Mw; Bradwell, 300 Mw; and Hunterston, 360 Mw. Four more stations are being constructed under the first nuclear power program: Dungeness "A," 500 Mw, and Sizewell, 580 Mw, both due

to be commissioned later this year; Oldbury, 560 Mw, 1966; and Wylfa, 1800 Mw, 1968. Under the second nuclear power program covering 1970-75, a further 5000 Mw of installed capacity is planned. (TCO)

**33616** CURRENT ORIENTATION ON THE TECHNICAL DEVELOPMENT AND COST REDUCTION OF ELECTRONUCLEAR POWER PRODUCTION. Ciuffa, D.; Sani, L. Energia Elettrica, 40: 379-99(1963). (In Italian)

Various economical aspects of nuclear reactors are considered and technological and economical data on future utilization of nuclear energy in industry are analyzed. A detailed analysis is given of the present costs of nuclear power production and of the potential future cost reduction. Tabulated data are included on the initial capital investment, production costs, and efficiency of various reactors including steam-cooled, gas-cooled reactors and superheaters. The economics and efficiency of small and medium power reactors are also discussed. (tr-auth)

**33617** ELECTRIC CHARACTERISTICS OF NUCLEAR POWER PLANT "ENRICO FERMI." d'Arminio Monforte, G.; Agnes, L. Energia Elettrica, 40: 865-77(1963). (In Italian)

General descriptions are given of the plant and of the most interesting features of electric systems, connection to h-v network, medium and 1-v equipment of operational and emergency service, and electrical system of reactor control with particular reference to safety criteria. (auth)

**33618** STANDPIPE SEAL FOR DUNGENESS NUCLEAR POWERSTATION. Wills, S. C. F. (Staachan and Henshaw Ltd., [Eng.]). Engineer, 218: 217-19(Aug. 7, 1964).

The design of the closure for standpipes, which are used to give access to the fuel channels or control assemblies of the Dungeness Reactor, is described. These closures must provide a seal against gas pressure ($CO_2$ up to 350 lb/in.$^2$) and a means to resist mechanical blow-out forces that this implies. A face-to-face seal requiring virtually no entry force was designed in which the reactions from balls engaging a groove in the standpipe and so retaining the closure against gas pressure was used to apply a downward acting force on to the face seal. A design exploiting the floating "O" ring was evolved. (M.C.G.)

**33619** CONCRETE PRESSURE VESSEL FOR WYLFA. Engineer, 218: 273(Aug. 21, 1964).

Two prestressed concrete pressure vessels were designed for the 1180 Mw Wylfa Nuclear Power Station. Each pressure vessel had to be spherical internally (96 ft dia) and had to contain the complete gas circuit for one reactor, including the core, boilers, and blowers. For shielding the minimum thickness of concrete had to be 11 ft. The vessels had a gas-tight steel liner 0.75-in. thick. The external shape closely approximated five concentric right circular cylinders with 16 vertical ribs. (M.C.G.)

**33620** DELICATE HANDLING MACHINE OF 400 TONS. Engineering, 197: 318-19(Feb. 28, 1964).

A fueling machine for use at the Trawsfynydd nuclear power station is described. It stands over 70 ft high with a total weight of over 400 tons. The function of the machine is to load and unload the uranium fuel elements from the reactor core, to replace the control rods and their mechanisms, and generally to service and maintain the items within the core. The refuelling is carried out while the reactor is "on load." Therefore, the machine has to withstand temperatures to 400°C and carbon dioxide coolant pressures to 250 lb/in.$^2$ since it forms an extension of the reactor gas circuit. A typical operation sequence is described and safety measures are discussed. (M.C.G.)

**33621** ENERGY OUT OF PEBBLES. Schulten, R. (Julich Nuclear Research Establishment, Ger.). Euratom Bull., 4: No. 2, 44-8(June 1965).

The AVR pebble-bed gas-cooled reactor is described. The pebble-bed principle is reviewed. Use of prestressed concrete for pressure vessels for pebble-bed reactors of this type is discussed. Helium lubrication for the blowers and integrated steam generators are described. Capital costs, burnups, and conversion factors are discussed. (M.C.G.)

**33622** HOW FAR HAVE WE GOT WITH THE ORGEL PROJECT. Orlowski, Serge. Euratom Bull., 4: No. 2, 50-4(June 1965).

Design studies for the ORGEL Reactor are reviewed. Studies on a terphenyl mixture for use as coolant, uranium carbide as fuel, and SAP as fuel cladding are described. Critical experiments are discussed. Costs of electric power supplied by an ORGEL power plant were calculated. (M.C.G.)

**33623** CIRENE. A NATURAL-URANIUM BOILING-WATER REACTOR PROJECT. Bahbout, Abraham. Euratom Bull., 4: No. 2, 54-60(June 1965).

Research on the Cirene Project for development of a boiling-light-water natural-uranium power reactor is described. A flow diagram for a Cirene-type power reactor is presented. Technical and economic advantages of this design concept are discussed. Fog cooling and burnout are described. Long-term prospects and specific problems of the Cirene Project are discussed. (M.C.G.)

**33624** HEAT CONTAINMENT IN THE PRESSURE-VESSEL WALL IN THE TOKAI POWER STATION. Nakanishi, Tsuneo (Fuji Electric Manufacturing Co., Ltd., Japan). FAPIG (Tokyo), No. 34, 234-7(Oct. 1964). (In Japanese)

The reactor pressure vessel for the Tokai Power Station was lined with insulating material on the outside and inside. The inner lining was done by using a prefabricated layer, consisting of flat and corrugated stainless steel plates welded together alternately. This inner lining was used above the primary gas sealing to the boron shielding. The outer lining, made of asbestos, was used in the area below the primary gas sealing. The lining was bound to the welded stud bolts with wire and covered with aluminum sheet. By the linings described, the heat loss from the vessel wall was reduced to <1% of the heat produced in the pressure vessel. (auth)

**33625** REACTOR INSTRUMENTATION FOR THE TOKAI POWER STATION. Matsumoto, Heita; Hatakeyama, Junichi (Fuji Electric Manufacturing Co., Ltd., Japan). FAPIG (Tokyo), No. 34, 238-41(Oct. 1964). (In Japanese)

Although the nuclear reactor for the Tokai power station was imported from England, a large portion of the reactor instrumentation was installed in Japan. Seven special items of instrumentation for the reactor are described. Eleven hundred alumel-chromel thermocouples are used to measure the temperatures of the graphite reactor core, fuel rods, and coolant channels automatically. Reactor control is achieved by 109 control rods in groups, and the positions of these control groups are indicated by high-precision potentiometers and control-rod drive mechanism. The reactor is scrammed by pouring rapidly 33 million boron-containing steel balls in the 44 stand pipes of the reactor. The neutron measurements for the reactor are carried out using three graphite blocks, each containing two pulse counters and six ion chambers. One of the two pulse counters counts the neutron flux in the startup range up to 25 w to 10 kw, and the other 1 kw to 10 Mw. One of the six ion chambers measures the logarithmic counting rate up to 1000 Mw, another the linear output signals, three the shutdown signals, and the remaining one the drift signals. Tungsten wires are inserted periodically and automatically into the ten stand-pipes to measure the neutron flux distribution in the graphite core. (auth)

**33626** TECHNOLOGICAL STATE OF POWER REACTORS OF THE TOKYO ATOMIC INDUSTRY. Morisima, Kurno. Genshiryoku Hatsuden, 7: No. 1, 21-4(1963). (In Japanese)

At present the main emphasis of the Khita Company's research is on boiling-water power reactors. The basic and applied theoretical studies in this field are described. Sufficiently precise computing methods in the nuclear engineering field have been developed and 70 types of programmed codes have been completed. Thus, the foundations have been laid for construction of power

reactors in Japan. Work on heat removal, reactor control, waste processing, radioactivity measurement and control, shock-proof reactor construction, etc. are described. Experiments and critical assemblies are described, together with the results of study and manufacture of ceramic uranium oxide fuel pellets and work on the construction of research reactors. A 3-phase study of atomic tankers is presented, made chiefly by the Kbita and Iino Companies; examples of preliminary data are presented. Analysis of the projects and their economics shows that atomic ships will not be able to compete immediately with ordinary ships if there is no great change in the cost of reactor equipment and of fuel for ordinary ships; and increase in the size and speed of atomic ships. Preliminary plans are presented for developing power reactors with superheating, and a heat-balance scheme for such a reactor is shown for use with 25,000-hp tankers. (IIC-MG)

**33627** A SURVEY AND PLANNING OF THE DEVELOPMENT OF POWER REACTORS IN JAPAN. Katovaki, Minoru. Genshiryoku Hatsuden, 7: No. 1, 28-31(1963). (In Japanese)

The planned construction and operation of an atomic power station with a boiling water reactor by the Japanese atomic industry are described. Work was completed on problems of constructing a 300-Mev reactor, and problems of construction and operation of the station were studied extensively. Boiling in the channels, a two-cycle heat-exchange system, and abnormal heat transfer were studied. Theoretical studies were also made to determine nuclear calculation data. The project was completed on an atomic ship for oceanographic studies, powered with a direct-cycle, boiling-water reactor; and work was done on an atomic tanker to determine the action of rolling and list of the ship on the hydrodynamic characteristics of the reactor. Satisfactory results were obtained in studies on methods of preparing thick rolls from clad steel welding and corrosion resistance, prevention of leakage through the ventilator of the large valves in the reactor cooling system, and corrosion and heat resistance of various materials. Uranium oxide fuel pellets were made with high precision by a vibration-densification method. An unusual feature of this method is the use of a plasma flame to melt the oxide powder, which gives high-density spheres. The effects of different conditions on the densification are being studied. A nuclear fuel system of thorium oxide–uranium oxide–graphite for semihomogeneous breeder reactors was developed. The construction of various reactors, design results, construction of reactor vessels, critical experiment apparatus, and other work done by Japanese firms in this field are described. A 12.5-Mev steam turbine and a 14,706-kva generator for the boiling water reactor were built for the Japanese Atomic Energy Research Institute. (IIC-MG)

**33628** INVESTIGATIONS CARRIED OUT BY "SUMITUMO" POWER ENGINEERING GROUP. Nagasima, Kukusaburo. Genshiryoku Hatsuden, 7: No. 1, 32-4 (1963). (In Japanese)

Studies made by Sumitumo concerned with power reactors, fuel, and materials are described, together with post achievements and plans for the future. Sumitumo has done work on establishing an integrated system for producing nuclear fuel. Methods were developed for producing $UO_2$ powder and metallic and alloyed uranium for sintering; for working dry $UO_2$, fluorinating, and reducing with thermite; and for working enriched metallic uranium. Techniques were studied for preparing fuel elements from natural metallic uranium, and uranium rods and fuel elements with improved properties by methods of melting and pouring under vacuum, rolling, and stamping. Significant success was achieved in making nonporous graphite bushings, plate and tubular fuel elements from aluminum-uranium alloy, and fuel elements from uranium-base alloy. In the field of ceramic and metallo-ceramic fuel elements, preparation of fuel elements from uranium oxide by vibration densification was studied. Definite success was achieved in studying dispersion type $UO_2$–Al fuel elements and uranium–graphite fuel elements for high-temperature power reactors. At present serial production of tubes and rolled material from stainless steel and pipes from special steel for reactor use is being carried out, and tubular shells are being made from Zr and Mg alloys. Corrosion of various materials by water, organic materials, liquid metals, and other substances is being studied. For fundamental work, light-water critical facilities are planned; and studies are being made on the properties of organic materials at high temperatures with more detailed studies on power reactors. (IIC-MG)

**33629** THE MEASUREMENT AND ANALYSIS OF CAN TEMPERATURE FLUCTUATIONS IN CHAPELCROSS REACTORS. Bentley, P. G.; Burton, E. J. (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Nucl. Energy. Pt. A & B, 19: 313-24(May 1965).

Fluctuating signals from can temperature thermocouples in Chapelcross reactors were analyzed by analog and digital methods to give power spectra and cross-power spectra in the frequency range from below 0.001 to 100 c/s. The measured signals were found to be almost stationary over periods of several days and are believed to be made up of three distinct components. At frequencies below 0.001 c/s, there is a component which may be drift in the control of the reactor and which is common to all fuel elements. At higher frequencies (0.001 to 0.01 c/s), a component of unknown source is inferred from its lack of correlation with other can temperatures. The third component has the characteristics of white noise smoothed by the time constant of the measuring thermocouple in the frequency range from 0.1 to 10 c/s and is believed to be caused by random heat transfer in the turbulent coolant gas. The amplitude of the third component is dependent on the local neutron flux and on the type of fuel element. (auth)

**33630** COMPARISON OF CONVENTIONAL AND NUCLEAR POWER STATIONS, USING THE TOP TEMPERATURE AS THE ECONOMIC FACTOR. Levai, Andras. Magy. Tud. Akad. Muszaki Tud. Oszt. Kozlemenyei, 35: 369-99(1965). (In Hungarian)

The temperature of the steam leaving the boiler is the most important factor affecting the specific investment cost and the specific heat consumption of conventional power stations. For nuclear power plants, the burnup and the amount and quality of the Pu produced must also be taken into consideration. The cost of high-temperature steam generated in fossile fuel plants depends markedly on the current price of heat-resistant steels. In nuclear plants, the temperature must be considered also from the viewpoint of nuclear physics, engineering and operations. Examination of the temperature dependence of the burnup in gas-graphite reactors revealed that it decreases with increasing temperature at a rate of about 1.4% per 100°C. Increase of the temperature also causes a reduction in the amount and the quality of the Pu produced. An economic optimization of the reactor-power plant system on the basis of the temperature is difficult because other factors, such as the effective initial multiplication factor, the amount of fissionable material in the core, must be also taken into account. Recrystallization and anisotropic swelling limit effectively the maximum temperature operated with Mg–Al clad natural U fuels. The efficient thermodynamic utilization of the heat available at a given temperature by the necessarily uneven temperature distribution in the core. Savings can be achieved and the investment cost may be reduced by taking advantage of the inherent overload capacity of reactors. (TTT)

**33631** NUCLEAR DESALINATION. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). Mech. Eng., 89: 107-9(May 1965).

The program to desalt sea water by nuclear energy is considered. It was found that with large dual purpose nuclear plants, power and water could be produced at competitive costs in water-short coastal areas by about 1975-1978 and that such installations would be valuable supplemental sources of municipal and industrial water. Dual-purpose plants fired by 200- to 1500-Mw reactors

were studied. The advantages of dual-purpose plants were confirmed, and there seems to be a sound basis for combining the production of these two utilities, especially with nuclear reactors as the heat source. Better use of the available heat is made; economies are offered by building one large plant instead of two smaller plants to produce the two products; and savings in certain equipment are possible. A wide range of plant sizes and reactor types was investigated and various assumptions on factors such as fixed charge rates, value of power, and plant load factor were employed. Considerable variations in the resulting predictions of the costs of water and power were found. The predicted costs, however, proved to be encouraging, and nuclear desalting plants especially those of a larger size, should be competitive with alternate methods of water supply. For example, a plant built for operation in 1970, which uses a 1500-Mw water-cooled reactor, is predicted to produce 190 Mw of electricity and 170 million gal/day of water at a cost of about 32¢ per 1000 gal. For a plant built for operation in 1975, which uses an 8300-Mw heavy-water reactor and produces about 1460 Mw of electricity and 620 million gal/day, the cost of water is predicted to be around 23¢ per 1000 gal. The electricity produced in a dual-purpose plant (the power value) can have a substantial effect on reducing water cost. For the plant using the 1500-Mw water-cooled reactor, the water price is lowered by about 2½¢/1000 gal for every mill/kw-hr of power selling price increase. In the case of the 1500-Mw water reactor plant, the cost was found to increase from ~32¢/1000 gal to 40¢/1000 gal when the entire plant load factor decreased from 80 to 60%. The reactor concept presently considered most promising for large-scale power desalting use is the heavy-water, organic-cooled reactor (HWOCR). The HWOCR concept offers significant potential for producing low-cost electric power and heat, especially in large single unit sizes. Because of its specific design features, extrapolation to a large-scale unit of up to 8 to 10,000 Mw capacity is considered technically feasible. The reactor also has the potential for very low energy costs whether used in power only or dual-purpose plants. As an advanced converter, the HWOCR also promises a substantial improvement in nuclear fuel utilization compared to present light-water reactors. It is expected that the initial prototype would be sufficiently developed to permit its operation in 1970. (BBB)

**33632** REACTOR SIMULATOR FOR TOKAI POWER STATION. Arai, Yoshio (Japan Atomic Power Co.), Otoba, Kotaro. Mitsubishi Denki, 39: 451-9(Mar. 1965). (In Japanese)

At present a nuclear power station operating on an improved Calder-Hall type reactor is under construction at Tokai-mura, Ibaragi-ken. It is expected to enter into commercial operation in September 1965. It has an output of 166 Mw and will be connected to a 154 kv system of the Tokyo Electric Power Co. Prior to the practical operation a simulator for the training and analysis was set up in July 1963 and was used for the training of the crew and analysis of various problems. Through the operation of the simulator, numerous facts were brought to light, and a number of experts familiar with reactor safety will be made available. (auth)

**33633** QUEBEC TO GO NUCLEAR WITH NEW DESIGN. Mod. Power Eng., 59: 106-9(May 1965).

Comparative figures are given for pressurized heavy water and boiling light water reactor designs. Advantages of the latter are described briefly. (F.S.A.)

**33634** PHYSICS ASPECTS OF BREEDER REACTORS. Went, J. J. (Keuring van Electrotechnische Materialen, N. V. Arnhem, Netherlands). Ned. Tijdschr. Natuurk., 30: 321-38(Oct, 1964). (In Dutch)

The physical constants necessary for obtaining a breeder effect are defined. The conditions that must be fulfilled by a thermal breeder reactor are tabulated. The properties of the different types of fast breeder reactors are tabulated and discussed. (J.S.R.)

**33635** EL4 AND THE FRENCH HEAVY WATER/GAS LINE. Carle, R. (CEA, [Paris]); Gibrat, R. Nucl. Eng., 10: 171-4(May 1965).

The development of heavy-water moderated gas-cooled reactors in France is discussed. A brief description is given of the EL4 including channel extensions, construction program, and the expected technical and economic performance. Forecasts are made on the medium and short-term role to be played by the graphite-gas, heavy water and fast breeder reactors. (L.B.S.)

**33636** MANUFACTURE OF THE SGHWR CALANDRIA. Duncton, P. J. Nucl. Eng., 10: 177-80(May 1965).

The manufacturing of the all-welded aluminum calandria for the SGHW reactor is described. The two major problems encountered were the development of welding techniques and the establishment of fabrication methods that ensured a finished calandria within close tolerances. The choice of the modified N4 aluminum-magnesium alloy was mainly dictated by the need to prevent subsequent stress corrosion. The fabricating accuracy and internal welding is discussed and the results of a pneumatic test at 16 psi are reported. (L.B.S.)

**33637** INVESTIGATIONS INTO THE GAS CIRCULATOR FAILURES AT HINKLEY POINT. Rizk, W.; Seymour, D. F. (English Electric Co. Ltd., Whetstone, Eng.). Nucl. Eng., 10: 180-1(May 1965).

The failures that occurred during the hot $CO_2$ test run at the Hinkley Point nuclear power station are discussed. A detailed inspection to determine the damage to circulators 1 to 6 was carried out using ultrasonic, magnetic, dyepenitrant, and x-ray techniques. Further tests conducted on circulator 7 and on a half-scale model originally used for aerodynamic development work are reported. (L.B.S.)

**33638** DESALINATION AND THE ROLE OF NUCLEAR POWER. Nucl. Eng., 10: 191-3(May 1965).

A brief review is given of the vapor compression, flash distillation and falling film methods of desalination, and diagrams are presented of typical processes. A survey is presented of distillation plants in operation and under construction around the world and a comparison of dual purpose plants powered by various types of reactors is shown. U.S.A. brackish water feasibility studies, water desalination development in Israel, and U. K. economic feasibility studies are discussed. (L.B.S.)

**33639** THE APPLICATION OF DYNAMIC PROGRAMMING TO FUEL MANAGEMENT OPTIMIZATION. Wall, Ian; Fenech, Henri (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 22: 285-97(July 1965).

A dynamic programing algorithm and a computer program were developed to optimize the refueling policies of a single-enrichment, three-zone, 1000-Mwe PWR core for a minimum unit power cost. The major assumptions necessary for this method are the representation of the fuel composition by the sole parameter, burnup, and the prediction of the system behavior by least-squares polynomial curves fitted to prior calculations. These approximations have been verified; their accuracy is about 3%. Many problems are displayed to demonstrate the application of the method. (auth)

**33640** RE-EXAMINING THE SIGNIFICANCE OF FISSION PRODUCTS IN ACCIDENT SITUATIONS. Brown, Karl K. Jr. Nucleonics, 23: No. 6, 55-9(June 1965).

The evaluation of reactor safety is discussed on the basis of information presented at a recent Oak Ridge symposium showing that fission product release from fuels in accidents was previously overestimated and that various mechanisms would further reduce the release from the reactor vessel. The behavior of radioiodine, particularly methyl iodine, is stressed; and a methodology for safety analysis of power reactors, presented at the symposium, is outlined. (D.C.W.)

**33641** DEVELOPMENT OF THE NATURAL URANIUM–GRAPHITE–GAS CHANNEL FROM E.D.F. 1 UP

TO E.D.F. 4. Roux, J.-P. Rev. Gen. Elec., 74: 239-51 (Mar. 1965). (In French)

The achievements in the field of nuclear power plants, from development of the EDF-1, EDF-2, EDF-3, and EDF-4 plant, are discussed. The changes in the profile of the plants and reactor units are revealed and the problems arising in the development of a nuclear plant, such as fuel elements, stacking of graphite, reactor units (in steel, then in prestressed concrete), carbonic gas blowers, heat exchangers, control rods, handling of fuel elements, and detection of defects in their sheathing, are reviewed. The different alternatives adopted are described. The time necessary for building of the plants, the cost of kilowatt-hour of electricity of nuclear origin, and the advantages of natural uranium-graphite-gas channels are discussed. (auth)

**33642** METHOD FOR DETERMINING THE OPTIMAL PARAMETERS FOR STEAM GENERATOR IN COMBINED ATOMIC POWER STATION WITH WATER PRESSURIZED REACTOR. Haiduc, C. Rev. Roumaine Sci. Tech., Ser. Electrotech. Energ., 9: 427-8(1964). (In Rumanian)

The method for optimizing the parameters for steam generators in the combined atomic power station. For the combined atomic power station the value for $\Delta t_1^{opt}$ and $w^{opt}$ is a function of the $\Delta t_r$ and $\bar{z}_c^0$. For different pressurized reactors with constant thermal power the $\Delta t_1^{opt}$ and $w^{opt}$ have different values. This method can be used for atomic power stations with classical fuel superheating. (auth)

**33643** INCIDENT BY COOLANT ESCAPE FROM THE PRIMARY PRESSURIZED SYSTEM OF THE PRO REACTOR. Franco, Cesari; Luciano, Bavestrelli. Riv. Ing. Nucl., 2: 629-34(Nov.-Dec. 1964). (In Italian)

The treatment of the incident by coolant escape from the primary system of the PRO reactor (a heterogeneous thermal reactor cooled and moderated by Santowax-R) follows from the examination of an analogous incident in a pressurized water reactor. Emphasis is given to the particularities of such an incident in an organic reactor. (tr-auth)

**33644** ATOMIC-POWER AND RADIATION APPARATUS. Toshiba Rev., Intern. Ed., 20: 258-66(Mar. 1965). (In Japanese)

Preparation has actively progressed for realization of domestic production of power reactors by the improvement of control-rod driving mechanism and the completion of enriched-uranium conversion equipment and pile oscillation equipment. On the other hand, actively participating in various schemes for promoting the output of JPDR as well as in the project of Japan Nuclear Power Ship Development Agency, Toshiba has contributed much to the atomic power development in this country. Improvement was also remarkable in the field of radiation apparatus, such as particle accelerators, radiation instruments, and x-ray apparatus. (auth)

**33645** PULSED NEUTRON MEASUREMENTS ON A HEAVY WATER POWER REACTOR AT ZERO ENERGY. Bronner, G.; Dio, W. H.; Schlosser, G. (Siemens-Schuckertwerke AG, Garching, Ger.). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/6, 25p. (CONF-650504-37)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The pulsed neutron method was used for zero-power measurements in the core of a heavy water reactor. Various methods were used for the evaluation of the pulse measurements. The so-called "integral" evaluation methods are based on theories published by Sjöstrand and Gozani; so far they have been mainly applied to light water reactors. These methods use not only the prompt neutron decay constant but also the information contained in the delayed neutron tails to determine the reactivity. For measurements on the heavy water reactor, however, the methods had to be modified to adequately take into account the time dependence of the delayed neutrons. The fraction of the delayed neutrons was calculated using a reasonable assumption for its time dependence. All the information needed could be obtained from the measurements. These methods are well suited for hand calculations to yield the reactivity with proper accuracy. An analytical procedure was applied to check the results of the integral methods. This essentially involves the exact calculation of the time dependence of the delayed neutron fraction by an iteration procedure. The results of the different evaluation methods mentioned above are compared by plotting them as functions of the $D_2O$ level and of the boron concentration. Due to the inclined control rods the flux distribution is distorted in a rather complicated manner when the rods are inserted. Therefore, the time dependence of this distribution was measured for different positions of the pulsed neutron source. It was possible to find one position for which the influence of higher modes on the measurements of the shut-down reactivity was sufficiently small. Finally, it is shown that the values of $[\delta\rho\,(H,c_i)/\delta(1/H^2)]\ H = H_i$ and $[\delta\rho\,(H_i,c)/\delta c]\ c = c_i$ ($\rho$ is the reactivity, and $H_i$ is the critical $D_2O$ level for boron concentration $c_i$) obtained by period measurements in the slightly supercritical state and pulse measurements in the subcritical state are in excellent agreement. (auth)

**33646** NUCLEAR REACTOR PLANT. Brunner, Alfred (to Gebrueder Sulzer AG). German Patent 1,183,606. Dec. 17, 1964. Priority date Apr. 28, 1961, Switzerland.

A nuclear reactor power plant is described in which the heat evolved in the reactor is absorbed by a coolant and transmitted in a heat exchanger to a working medium in at least two vapor generators operating at different pressures, in which the working medium is thereby vaporized and then performs mechanical work in a turbine. The working medium flows through coils in the heat exchanger in countercurrent to the coolant. The reactor has at least two zones of different heat evolution with different coolant output and input temperatures. The coolant is fed to and discharged from the heat exchanger at different inlet and outlet points according to its temperature, and the heat exchanger is divided into two parts through which the coolant flows successively and between which parts there is a blower for circulating the coolant. (Gmelin Inst.)

**33647** BOILING WATER NUCLEAR REACTOR WITH DRYING AND SUPERHEAT ARRANGEMENT. Soederholm, Lars Erik (to Allmanna Svenska Elektriska AB). U. S. Patent 3,178,358. Apr. 13, 1965. Priority date Dec. 28, 1961, Sweden.

In the reactor described, liquid coolant is heated at least to the boiling point as it is brought upward along the outside of tubular fuel assemblies. At the end of the fuel assemblies the coolant is brought by guiding blades into fast rotation inside a funnel-shaped surface, and steam and liquid are separated. The liquid is collected and recirculated. The steam is led downward through the inside of the tubular fuel assembly past guiding flanges that bring the flowing steam into rotation. The steam is superheated during the downward passage and is led to a collecting place for superheated steam beneath the fuel assembly. (A.G.W.)

**33648** NUCLEAR REACTOR PLANT. Profos, Paul (to Sulzer Freres, S. A.). U. S. Patent 3,153,620. Oct. 20, 1964. Priority date Aug. 29, 1960, Switzerland.

In the nuclear reactor plant patented, two separate primary circuits of two different heat carriers transfer the heat generated in the reactor to a common secondary circuit of an evaporable operating medium. The heat exchange conditions in the reactor core are preferably so chosen that the heat carriers of the two primary circuits leave the reactor at different temperatures. The heat carrier having the lower temperature is used to evaporate the operating medium, while that having the higher temperature yields at least some of its heat to a superheater for the operating medium. (A.G.W.)

**33649** SAFETY EQUIPMENT FOR NUCLEAR POWER-REACTOR PLANTS. Ziegler, Albert; Petersen, Gerd (to Siemens-Schuckertwerke AG). U. S. Patent 3,168,445. Feb. 2, 1965. Priority date June 14, 1961, Germany.

A sprinkler system for condensing the steam that escapes in the event of reactor failure is of a siphon type and needs no particular releasing device. A water storage tank is located at the highest point of the pressure-resistant steel reactor enclosure. The outgoing pipes for sprinkler water enter the tank from above and terminate below the water level. The enclosed air space above the water level in the storage tank is connected by pipes to the reactor space proper. When pressure rises above a predetermined level in the reactor space, water is forced from the storage tank into the pipes and to the sprinkler devices below. (A.G.W.)

**33650** NUCLEAR REACTOR VAPOUR GENERATING PLANT. Wootton, William R. (to Babcock and Wilcox Ltd.). U. S. Patent 3,171,791. Mar. 2, 1965. Priority date Dec. 23, 1959, Great Britain.

A steam generating plant is designed for use with a nuclear reactor cooled by a liquid alkali-metal coolant. The plant utilizes a direct-contact steam generation arrangement, which includes a cascade of feedwater evaporating drums and superheaters. The design is intended to reduce the capacity of the pump required. (A.G.W.)

**33651** METHOD OF OPERATING A STEAM GENERATING NUCLEAR REACTOR. Bradley, Norman (to United Kingdom Atomic Energy Authority). U. S. Patent 3,174,907. Mar. 23, 1965. Priority date June 4, 1959, Great Britain.

In the steam-generating nuclear reactor described, steam is produced by direct contact with the heat-producing core of a reactor. A first mixture of feed water and steam is passed through a first group of channels in the reactor core to raise saturated steam. This saturated steam is mixed with new feed water and the resulting second mixture is passed through a second group of channels in the reactor to raise further saturated steam, which then is passed through a third group of channels for superheating. (A.G.W.)

## Process Heat Reactors

**33652** SUBCRITICAL BOREHOLE NUCLEAR REACTOR AND PROCESS. Kehler, Paul (to Phillips Petroleum Co.). U. S. Patent 3,170,842. Feb. 23, 1965. Filed Nov. 6, 1961.

A subcritical nuclear reactor having variable power output is suitable for use in a well bore for well logging purposes, for heating the formation, or for pyrolysis of oil shales. The reactive nuclear fuel is divided into separate subcritical fuel zones and is energized to a level of neutron production or power output dependent on the position of a primary neutron generator, which is moveable relative to the body of the reactor. The neutron generator is secured to the reactor by a thermal fuse link so that, if the heat of reaction reaches a predetermined excessive value, the link will melt, allowing the generator to fall into a well in a neutron shield and stopping the reaction. (A.G.W.)

**33653** HEAT TREATING METHOD AND MEANS UTILIZING NUCLEAR ENERGY. Schulten, Rudolf (to Brown, Boveri and Cie AG). U. S. Patent 3,181,999. May 4, 1965. Priority date Mar. 24, 1959, Germany.

A process is described for the heat treatment of material for performing chemical endothermic reactions with the aid of nuclear fission energy to supply the heat. The reaction is carried out in a graphite reactor block and may be carried out in a continuous process. The material may be processed either while the reactor is critical and generating heat or after the core has attained the desired temperature and the reactor has been shut down. If the moderator core contains both horizontal and vertical channels for fuel elements, the horizontal channels may be occupied by the fuel elements, and material in the vertical channels may be processed and removed from the reactor without shutting down the reactor. Alternately, the block may be allowed to reach the predetermined temperature, part of the fuel elements are withdrawn, the material to be processed is introduced into the vacant places in the moderator block and the reaction products are removed when the reaction is complete. The fuel elements may then be re-inserted and the process repeated. Calcium carbide is conveniently prepared from CaO in a reactor at a temperature of about 1620 to 2200°C. (B.L.M.)

## Production Reactors

**33654** (HW-SA-3637) REACTOR SAFETY SYSTEM MECHANISM. Nesbitt, J. F. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). July 24, 1964. Contract AT(45-1)-1350. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The design and operating characteristics of mechanisms that open hoppers in the safety systems of the Hanford production reactors are described. The opening of the hoppers by these mechanisms allows ceramic poison pellets to fall into receptacles in the reactor cores, thus shutting down the reactors. The fail-safe nature, speed of response, and ability of the mechanism to operate remotely and reliably is discussed. (T.F.H.)

## Propulsion and Space

**See also ENGINEERING — Space Propulsion.**

*Refer also to abstracts 32409, 32615, and 33626.*

**33655** (SC-DR-64-578) DEVELOPMENT AND TESTING OF A RECOVERY SYSTEM FOR THE SNAP-10A RE-ENTRY VEHICLE. Kane, M. T.; Widdows, H. E.; Lucero, H. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Presented are details of the design, fabrication, and testing of a parachute and flotation system for the SNAP-10A, RFD-1 re-entry vehicle. (auth)

**33656** THE LOS ALAMOS NUCLEAR-ROCKET PROGRAM. Spence, Roderick W.; Durham, Franklin P. (Los Alamos Scientific Lab., N. Mex.). Astronaut. Aeronaut., 3: No. 6, 42-6(June 1965). (LA-DC-7062)

The accomplishments made on the Rover nuclear rocket program since its existence are surveyed. Time profiles of major variables, pressures, control rod positions, and inlet temperatures in the first full-power test of Kiwi-B-4E are shown. A brief discussion is given on the NRX-A2 test results and future tests in the Nerva series. The developments in the advanced graphite-based reactor program (Phoebus) are discussed. (L.B.S.)

**33657** THE DEVELOPMENT OF NUCLEAR REACTOR PLANTS FOR MERCHANT SHIPS — A WORLD SURVEY. Salander, C.; Ulken, D. (Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomwirtschaft, 10: 214-22(May 1965). (In German)

A survey is presented of the development of nuclear reactor plants for merchant ships in the USA, Japan, Europe and the Federal Republic of Germany. (L.B.S.)

**33658** NUCLEAR PROPULSION FOR MERCHANT SHIPS IN THE EURATOM PROGRAM. Rojahn, W.; Jacquot, A. (Kommission der Europaischen Atomgemeinschaft, Brussels). Atomwirtschaft, 10: 223-6(May 1965). (In German)

An essential superiority of the reactor installations basically rests on the fact that they can be built for higher performances because the nuclear fuel is included in their weight and space requirements and, indeed, in amounts sufficient for several years' operation. It turns out that for powers over 80,000 SHP lower specific weights can be obtained with ship reactors than with steam boiler or motor plants without taking into account conventional fuels. The known conditions of present day merchant shipping are, however, not sufficient for judgements about the economic status of atomic ships since these must be used in a way that exploits their specific superiority. The prerequisites for this should emerge from the current experimental and

theoretical development work supported by Euratom. The Euratom Commission has maintained this support since 1961 through the work of its own experts, by financial participation and by the exchange of information. One of the four Euratom contracts so far concluded covered, retrospectively, work which was begun in 1959 while the three current contracts provide for periods up to 1967 and 1968. Euratom is concerned now in the design, construction and operation of the first atomic merchant ship, the German "Otto Hahn," whose sea trials should begin in 1967. The contracts concluded between the Euratom Commission and the Dutch RCN and the Italian firms of Fiat and Ansaldo are already mainly concerned with economic aims. It is expected that around 1970 it will be possible to embark on the construction of nuclear powered merchant ships that will at least meet the bounds of profitability. (auth)

**33659** THE NUCLEAR PROPULSION PLANT FOR THE OTTO HAHN. Schueler, R. (Deutsche Babcock and Wilcox Dampfkessel-Werke AG, Oberhausen, Ger.), Weisbrodt, I.; Wiebe, W. Atomwirtschaft, 10: 227-40(May 1965). (In German)

A detailed description is given of the advanced pressurized water reactor installation and plant components for the Otto Hahn nuclear ship. The important data of the propulsion-installation are tabulated. The operating system, design, construction, electronic equipment, controls, instrumentation, and fuel loading are discussed. (L.B.S.)

**33660** ITALIAN SHIP REACTOR DEVELOPMENT. Vallauri, M. (Fiat Sezione Energia Nucleare, Turin). Atomwirtschaft, 10: 241-3(May 1965). (In German)

The present status is given on the development of a 52,000 tdw tanker with a compact pressurized water reactor with forced circulation and a rating of 29,000 SHP. The intermediate project consists of the nuclear, thermohydraulic, and structural planning of the reactor; and the design and construction of the reactor layout accompanying experimental development. (L.B.S.)

**33661** CONSOLIDATED NUCLEAR STEAM GENERATOR FOR MARINE APPLICATION. Engineer, 218: 297-300(Aug. 21, 1964).

The third design concept for the Consolidated Nuclear Steam Generator (C.N.S.G.) is described. It was developed from the N. S. Savannah reactor design. However, the steam generator is inside the reactor pressure vessel in the third concept to provide a more compact layout. The fuel is low-enriched $UO_2$ contained in Zircaloy tubes. The steam generator is a once-through boiler without a steam drum. For applications between 20,000 and 30,000 shp, shop prefabrication and fit-up are considered feasible. Diagrams of the design are given. Economic aspects including fuel costs are discussed. (M.C.G.)

**33662** SNAPSHOT: HISTORIC FIRST IN SPACE. Nucleonics, 23: No. 6, 43-8(June 1965).

On April 3, the orbital testing of SNAP-10A and of an ion engine was initiated with the SNAPSHOT launching. The development and pre-flight testing of SNAP-10A are summarized, together with possibilities for future development of such systems. The requirements on propulsion systems for space are also outlined, together with the types and uses of electric propulsion devices. (D.C.W.)

## Research and Test Reactors

*Refer also to abstract 32447.*

**33663** (AERE-M-1563) IRRADIATION OF SMALL SAMPLES IN THE REACTORS DIDO AND PLUTO. Truswell, A. E. (Atomic Energy Research Establishment, Harwell (England)). May 1965. 22p. Dep.; $0.70(BIS); 3s. 6d. (HMSO).

The materials testing reactors DIDO and PLUTO are both equipped with facilities for irradiating small samples. Guidance is provided on the safety aspects of such irradiations. (auth)

**33664** (BNL-9086) HIGH FLUX IRRADIATION FACILITY STUDY. PROPOSED CONVERSION OF BGRR TO $D_2O$-COOLED, PRESSURE-TUBE-TYPE REACTOR. Hoffman, K. C.; Lellouche, G.; Ahlers, G.; Thompson, D. (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 39p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An analysis is carried out of the possibility of modification of the Brookhaven Graphite Research Reactor in order to increase its thermal neutron flux to at least $10^{14}$ neutrons/cm$^2$/sec. The engineering, economic, and neutronic aspects of this modification are studied. The modification finally consisted of an 80-Mw, heavy-water-cooled, pressure-tube reactor having a 12-ft long fueled region. Data are included in tabular and graphic form. (T.F.H.)

**33665** (BNWL-60) FERTF PROGRAM PROGRESS AND PLANS QUARTERLY REPORT, JANUARY–MARCH 1965. Stoddard, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The rupture testing of a vibrationally compacted $UO_2$ fuel element defected with a longitudinal slit is described. (W.L.G.)

**33666** (EUR-2243.f) SYSTEME DE REGENERATION BOUCLE ORGANIQUE NO. 2. (Regeneration System: Organic Loop No. 2). Masson, M.; Auche, J. P.; Robail, L. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1965. 18p. Dep.(mn).

Under the ORGEL Program, organic liquid high temperature irradiation loops were installed in the Mélusine reactor at the Nuclear Study Centre, Grenoble (CEA). In order to maintain a fixed liquid composition, one of the loops was fitted with an automatic device for drawing off the irradiated liquid and injecting fresh fluid. The equipment is described in this report. (auth)

**33667** PROPERTIES OF RADIOACTIVE NUCLIDES CONTAINED IN COOLING WATER OF THE ATOMIC REACTOR JRR-1. Ojima, Tsutomu; Toratani, Hirokazu (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 93-5(Mar. 1965).

In primary cooling water of the atomic reactor JRR-1, there were detected such metals as Fe, Ni, Mn, Si, B, Mg, Cu, Zn, Ca, Al, and Pb by emission spectrometry and such radioactive nuclides as $^{60}$Co, $^{54}$Mn, and $^{58}$Co by $\gamma$ spectrometry. In addition, relationships between the size of intermixed particles and their radioactivity, and between the pH of cooling water and the radioactivity were examined. The evidence obtained supports the suggestion that these metals were dissolved from the wall of the cooling-water container in an ionic state and that some of them were radioactivated during circulation in the cooling process. From the relationships between the radioactivity and the pH, and between both and the size of particles, the following suggestions are supported: although most of the radioactive nuclides exist in the state of ions, some parts of them are adsorbed on precipitates of metal hydroxides; as the pH of the water becomes higher than 7, these radioactive nuclides begin to precipitate in the state of radiocolloids, and the ratio of radiocolloid formation increases with increasing pH of cooling water. (auth)

**33668** BEHAVIORS IN MARINE WATER OF RADIOACTIVE NUCLIDES CONTAINED IN COOLING WATER OF THE ATOMIC REACTOR JRR-1. Ojima, Tsutomu; Toratani, Hirokazu (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 96-8(Mar. 1965).

In a fundamental survey of the behavior of radioactive nuclides in marine water, the cooling water of the atomic reactor JRR-1 and a $^{60}CoCl_2$ solution were used as radioactive substances. It was recognized that the radioactive nuclides contained in primary cooling water in the ionic state formed radiocolloids partly because of the higher pH of marine water. No precipitates were formed as a result of direct reaction with marine salts. It was supposed that radioactive nuclides would be adsorbed by planktons and mud floating in marine water at compara-

tively low ratio. It was considered, consequently, that most radioactive nuclides would be diluted with marine water and moved away with a current, but, as they had a chance of contact with mud, most of them would be fixed by the mud. In this case the fixation ratio was larger for $^{60}Co$ than for $^{54}Mn$ and these radioactive nuclides were fixed firmly in the non-exchangeable state. (auth)

**33669** CONSTRUCTION OF JAPANESE RESEARCH REACTOR No. 4. Yaken, T.; Tadashi, Hara. Genshiryoku Kogyo, 9: No. 6, 49-53(1963). (In Japanese)

The graphite-reflected pool-type reactor JRR-4 is described, together with plans and special equipment for its use in shielding experiments. The fuel elements are made of Al–U alloy, and the control elements are stainless steel containing boron. The average thermal neutron flux is $10^{13}$ $cm^{-2}$ $sec^{-1}$. (D.C.W.)

**33670** USEFULNESS AND DESIGN STUDY FOR HUTR. Yamashita, Shizuo (Sumitomo Atomic Energy Industries, Ltd., Japan), Takekoshi, Isao. Meidensha Jiho, No. 57, 27-30(Oct. 1964). (In Japanese)

Sumitomo Atomic Energy Industries, Ltd., commissioned the JAERI, the design study of the High Temperature Unit Cell Test Reactor, and the results obtained are given. The reactor is derived from the PCTR in the US, but is different from the latter in the installation of a high-temperature loop in which the measurement of nuclear characteristics at high temperature is possible. The main purpose of HUTR is to obtain data for designing a graphite-moderated, gas-cooled reactor. Studies were made of the optimum spacing in the core lattice, the reactivity coefficient in the change of the cell design, excess reactivities for burnup and plutonium cycle, lattice arrangement for the flattening of the power output, and temperature coefficients. Principles of the measurements using the HUTR are described. Results are given, including the critical size dependence of the thermal neutron spectrum, flattening of the neutron flux, and the shutter-type control rods. (auth)

**33671** MEASUREMENT OF THE PARAMETER B/l IN THE GRAPHITE-WATER ZERO-POWER REACTOR ANNA USING A PULSED NEUTRON SOURCE. Chwaszczewski, S.; Dybowski, K. Vienna, International Atomic Energy Agency, 1965, Paper SM-62/102, 16p. (CONF-650504-15)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

In pulsed measurements, the parameter $\beta/l$ of a reactor is normally equated with the attenuation constant of prompt neutrons with the reactor at delayed criticality. This approximation is true when $\beta/l \gg \lambda_1$ where $\lambda_1$, the attenuation constant, is shorter than the shortest-lived group of delayed neutrons. In the ANNA reactor, this condition is not fulfilled ($\beta/l \sim 10$ $sec^{-1}$ and $\lambda_1 \sim 3$ $sec^{-1}$), and a number of difficulties are therefore encountered in making measurements when the reactor is close to the critical state. In the first place, there appears a background of delayed neutrons which varies greatly during one measuring cycle. To separate the time dependence of the prompt neutron density, tables of the delayed neutron background were compiled using the numerical solutions of the reactor kinetics equations. The corresponding matched background was calculated from the experimental data using a special computing technique. The value of $\alpha$ when the reactor is critical was obtained by extrapolating sub-critical measurements to the critical state. The magnitude of $\beta/l$ was obtained from the value of $\alpha_{cr}$ using the tables compiled from the results of numerical solutions of the reactor kinetics equations. At high negative reactivities ($|\rho/\beta| \geq 2$), the attenuation constants $\alpha$ were obtained directly from the experimental data using the KANDIDE code with a URAL-2 computer. The reactivities were determined on the assumption that $\beta/l$ is a constant from the tables compiled. The calculated reactivities obtained in this way were compared with values obtained by other methods. Measurements were made for several reactor core configurations. The pulsed source was an IGN-200 pulsed deuteron accelerator with a tritium target. The target of the generator was situated on the boundary between the core and the reflector. The time dependences were measured using a Victoreen ST-400 DM 400-channel time analyzer. (auth)

**33672** MEASUREMENTS OF THE THERMAL NEUTRON SPECTRUM IN THE CORE OF THE FORSCHUNGSREAKTOR FRANKFURT (FRF). Rossberg, D. (Johann Wolfgang Goethe Universitat, Frankfurt am Main). Vienna, International Atomic Energy Agency, 1965, Paper SM-62/7, 16p. (CONF-650504-36)

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

The thermal neutron spectrum in the core of the FRF was measured using a neutron chopper facility. The FRF is a homogeneous water-boiler reactor (Type L 54 F, Atomics International). Its fuel solution mainly consists of uranylsulphate (400 g $UO_2SO_4$/litre, enriched in $^{235}U$ to 20%), water and sulphuric acid (concentration 0.4 molar). The absorption cross section per proton of the solution is 1.85 barns. To extract neutrons from the core, a zirconium scatterer was placed in the central beam tube (through-hole) of the reactor. The scatterer could be positioned at various distances from the core centre. The measured spectra can be described in good approximation by a Maxwell distribution. The neutron temperatures determined from the spectra are higher than those reported in the literature for moderating water systems poisoned by an equivalent amount of absorber. The higher neutron temperature may be explained by assuming an increased effective mass of the moderating protons in the fuel solution. In the joining region between thermal and epithermal energies the spectra differ from those reported for pure water. The cut-off energy of the epithermal spectrum is found to be about $E_n = 5\ kT_n$, $T_n$ being the neutron temperature of the Maxwell spectrum. In the course of these measurements, the influence of the zirconium scatterer on the neutron spectrum in the extracted beam was investigated. The total neutron cross section of zirconium in the energy range between 0.002 and 0.1 ev was measured. The results show that only at neutron energies $E_n > 0.02$ ev the total neutron cross section of zirconium is nearly independent of neutron energy. Below this value coherent scattering in zirconium strongly affects the spectral distribution in the scattered beam. (auth)

**33673** SWIMMING POOL REACTOR FOR STUDYING MATERIALS UNDER IRRADIATION. Horowitz, Jules; Raievski, Victor (to Commissariat a l'Energie Atomique, Paris). U. S. Patent 3,177,121. Apr. 6, 1965. Priority date May 20, 1960, France.

The reactor patented includes a casing immersed in a pool and having compartments in which the fuel elements of the reactor core are located. The core is cooled by independent forced circulation of water, and the movement of fuel elements, control rods, and control instruments is accomplished from a position directly under the reactor. Articles to be irradiated are supported and moved into proximity with the core by carriages operating on tracks on the bottom of the pool and extending radially in relation to the core. Means for radioscopic observation of the irradiated articles and means for maneuvering the articles from outside the pool are provided. (A.G.W.)

**33674** MULTI-PURPOSE REACTOR. Leonard, Byron H., Jr. (to Internuclear Co.). U. S. Patent 3,177,122. Apr. 6, 1965. Filed Feb. 23, 1960.

A reactor for testing and training purposes is of the swimming pool type and is designed for maximum flexibility. A hexagonal core tank located at the bottom of a pool in spaced symmetrical relation with the walls of the pool contains a grid for supporting diamond-shaped containers. The containers may be filled with any desired combination of nuclear fuel and neutron reflector, moderator, or absorber materials and may be placed in side-by-side contact to fill the core tank. On the outside of the core tank are special chambers that may be packed with reflector material or flooded to provide bulk shielding. A simple system can be used for either heating or cooling the pool water. Suitable instrumentation is provided for monitoring and control systems. (A.G.W.)

# WASTE DISPOSAL AND PROCESSING

**See also BIOLOGY AND MEDICINE — Ecology.**
**CHEMISTRY — Radiochemistry.**
**CHEMISTRY — Separation Processes and Procedures.**
**HEALTH AND SAFETY.**

*Refer also to abstracts 32495 and 33668.*

**33675** (IDO-14608) DEVELOPMENT OF FLUIDIZED BED CALCINATION OF ALUMINUM NITRATE WASTES IN THE WASTE CALCINING FACILITY. Lakey, L. T.; Lohse, G. E.; Palica, W. P. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). May 1965. Contract AT(10-1)-205. 150p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Development of the fluidized bed process for converting nuclear fuel reprocessing wastes to granular solids during the 3700 hours of non-radioactive test operation of the plant-scale ICPP Waste Calcining Facility is described. (auth)

**33676** (ORNL-3640) LABORATORY DEVELOPMENT OF PROCESSES FOR FIXATION OF HIGH-LEVEL RADIOACTIVE WASTE IN GLASSY SOLIDS. 3. WASTES FROM THE PUREX SOLVENT EXTRACTION PROCESS. Clark, W. E.; Godbee, H. W.; Fitzgerald, C. L. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 61p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Glassy solids suitable for the long-term storage ("ultimate disposal") of radioactive wastes were prepared from solutions simulating those obtained or expected from the processing of nuclear fuel by the Purex solvent extraction process. The studies were applicable to both rising level (RL-Potglass) and continuous glass (Con-Potglass) processes. The simulated waste solutions studied varied from those in which sodium sulfate was the principal constituent to those which contained no sulfate. Simulated fission products varied from zero to amounts expected from a burn-up of 35,000 Mwd/metric ton. Actual radioactivity was limited to tracer amounts used in determining leaching rates and volatilities. Minimum volumes of "glass" obtained (at 0.2% simulated fission products) corresponded to about 2.7 gallons of solid per ton of uranium processed. This solid contained 46% (by weight) waste oxides (process oxides plus simulated fission products), 31.5% $P_2O_5$, 11.8% $Al_2O_3$, 7.4% $Li_2O$, and 4.9% CaO. Melts incorporating higher concentrations of fission products required higher percentages of fluxing agents to keep melting temperatures and viscosities low enough for practical operation in stainless steel equipment. Maximum temperatures allowable are about 1050 and 900°C for the rising level (RL-Potglass) and the continuous melting glass (Con-Potglass) processes, respectively; lower operating temperatures are desirable in both cases. Phosphate, aluminum, sodium, lithium, and calcium were the principal fluxing agents used for sulfate-containing wastes. The most glassy non-sulfate melts were obtained with phosphate and lead as fluxes. Increasing the content of aluminum or of fission products generally increased softening and melting temperatures but resulted in a more uniform product. Addition of lithium to give a final ratio, Na/Li ≅ 1 usually resulted in less soluble, more homogeneous, and lower melting solids than when only sodium was present. Volatility of sulfate was minimized by keeping the ratio [chemical equivalents (alkali + alkaline earths)/chemical equivalents ($PO_4^{3-}$ + $SO_4^{2-}$ + other nonvolatile anions)] ≥1.1 to form a "neutral" glass. Leaching rates of $^{137}Cs$ from two sulfate-containing ceramics corresponded to penetration rates of about $10^{-4}$ g cm$^{-2}$ day$^{-1}$. The thermal conductivity of a true "glass" product was 1.3 to 1.7 Btu hr$^{-1}$ ft$^{-1}$ °F$^{-1}$ vs 0.2 to 0.7 Btu hr$^{-1}$ ft$^{-1}$ °F$^{-1}$, for a calcined product. Vapor-liquid equilibria and densities were measured for sulfate-containing waste solutions. Titanium was the most resistant material tested for use in the evaporator, condenser, and off-gas lines. The maximum rate observed was 3.3 mils/month; expected rates are ≪1 mil/month. Stainless steel and nickel alloy suffered severe intergranular attack under the most aggresive conditions. Wastes of low acidity (i.e. "acid killed") wastes were relatively noncorrosive (≦0.3 mil/month) toward stainless steel and nickel alloys and even less corrosive toward titanium. Stainless steel is sufficiently resistant to serve as the fixation-storage vessel for the RL-Potglass process in spite of relatively high corrosion rates. Stainless steel is also suitable to contain waste for final storage in salt. (auth)

**33677** (RL-SEP-496) WASTE MANAGEMENT PROGRAM. CHEMICAL PROCESSING DEPARTMENT. REVIEW OF COSTS AND INCENTIVES. Beard, S. J.; Smith, P. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 25, 1965. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Currently projected costs for the Waste Management Program are reviewed, and current estimates are given of the costs for the two alternative programs, perpetual tank storage and interim storage and solidification. The incentives for the fractionization and solidification approach are discussed. (D.L.C.)

**33678** DECONTAMINATION OF RADIOACTIVE WASTE WATER BY HUMIC ACID COLUMN. Matsumura, Takashi; Ishiyama, Toshio (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 33-6(Mar. 1965).

Humic acid has a characteristic cation exchange property. Decontamination of radioactive waste water by a humic acid column was tested. When only very small amounts of foreign matter are present in the water to be decontaminated, $^{89}Sr$ and $^{137}Cs-^{137}Ba$ are satisfactorily removed from neutral solution; $^{95}Zr-^{95}Nb$, $^{144}Ce-^{144}Pr$, and FP are effectively removed by acidification of the liquid, but nitratonitrosylruthenium is not removed effectively. When an appreciable amount of carrier ions is present, the removals of $^{89}Sr$ and $^{137}Cs-^{137}Ba$ decrease relatively quickly with the concentration of carrier ions. It seems that the cation exchange property of humic acid works mainly on the surface of the humic acid preparation. (auth)

**33679** DECONTAMINATION OF RADIOACTIVE RUTHENIUM BY CELLULOSE DERIVATIVE BENTONITE FLOCCULATION. [PART] II. Ishiyama, Toshio; Matsumura, Takashi (Radiation Center of Osaka Prefecture). Ann. Rept. Radiation Center Osaka Prefect., 5: 37-42(Mar. 1965).

The decontamination properties of cellulose anion exchanger-bentonite flocculation were studied with respect to removal of fission product Ru. An efficient decontamination of fission product Ru through DEAE cellulose-bentonite flocculation can be achieved by treating the fission product solution with hydrochloric acid and sodium nitrite and changing nonionic nitrato complex of $^{106}RuNO^{3+}$ ion into $[^{106}RuNO(NO_2)_4OH]^-$. The formation of "organo-clay complex" through combination of DEAE cellulose and bentonite plays an important role in raising the removal of Ru, possibly because of the high adsorption capacity of "organo-clay complex" for $[^{106}RuNO(NO_2)_4OH]^-$. Tertiary amine cellulose is superior as the agent for bentonite flocculation to quaternary amine cellulose. (auth)

**33680** RETENTION OF FISSION PRODUCTS BY THE HUMIC ACIDS OF PEAT—A NEW METHOD FOR THE

TREATMENT OF EFFLUENTS. Szalay, Sandor; Szilagyi, Maria (Inst. of Nuclear Studies, Hungarian Academy of Sciences, Debrecen). Fiz. Szemle, 15: 388-91(Dec. 1964). (In Hungarian)

Previous studies carried out at the Institute of Nuclear Studies revealed that the uranyl cation is strongly sorbed on the insoluble humic acids which behave similarly to the carboxylic synthetic ion-exchange resins. The sorption is not specific for $UO_2^{2+}$ ions. The problem was studied by tracer method, examining the behavior of fission products in dilute aqueous HCl solutions. The peat used for the tests was collected from below the water table where it was protected from oxidative decay. It was found that the long half life, biologically dangerous cations, such as rare earths, Zr, Sr and Cs are strongly sorbed while anionic materials—I, Rn, Se, Nb, Sb and Te and the noble gases—are not retained. $^{95}Zr$ was most strongly held, it could not be eluted even with 1N HCl. But its daughter, $^{95}Nb$, is not sorbed at all. The degree of sorption is strongly dependent on the valence of the cation. The method is considered potentially useful for the large-scale treatment of radioactive waste effluents containing fission products, provided that the liquors do not contain strong acids, keeping the acidity between 4 and 6, and are free from dissolved stable cations, such as $Zr^{4+}$, $Fe^{3+}$ and $Al^{3+}$; complexing agents should also be absent. Although no large-scale tests have been carried out, it appears feasible to discharge the waste effluents into uninhabited marshy areas containing large amounts of peat. (TTT)

**33681** GEOLOGIC, HYDROLOGIC, AND SAFETY CONSIDERATIONS IN THE STORAGE OF RADIOACTIVE WASTES IN A VAULT EXCAVATED IN CRYSTALLINE ROCK. Proctor, J. F. (E. I. du Pont de Nemours and Co., Aiken, S. C.); Marine, I. W. Nucl. Sci. Eng., 22: 350-65(July 1965). (TID-20627)

A recent investigation established the technical feasibility and indicated the high degree of safety that could be afforded by the storage of high-level radioactive wastes in unlined vaults excavated in crystalline rock 1500 ft beneath the surface of the Savannah River Plant near Aiken, S. C. The crystalline rock at the proposed site is covered by 1000 ft of unconsolidated sediments consisting predominantly of sand and clay. A virtually impermeable layer of clay separates the rock from the overlying sediments in which several prolific water-bearing zones occur. The separation of the waters above and below this clay layer is confirmed by their different chemical composition and by the presence of dissolved helium-bearing gas only in the water in the rocks beneath the clay. Based on geologic and hydrologic information obtained in an intensive drilling and testing program, upper limits on the rates of water movement through the crystalline rock are calculated to be 1.5 to 7 ft/year, depending upon the degree of fracturing of the rock. Comparable data on the unconsolidated sediments lead to a calculated maximum rate of water movement of 350 ft/year. The most significant driving force for the migration of radionuclides from the storage site is derived from the natural water movement, coupled with effects due to dispersion and ion exchange. Characteristics of the waste, heat generation, and radiolysis have, by contrast, only small effects on migration. Three barriers prevent migration of the radionuclides: the very low permeability of the rock in which the storage vault is located, the virtually impermeable clay layer separating the rock and sediments, and the ion exchange properties of the sediments. Any one of these barriers is capable of confining the radionuclides well within the plant boundaries for a time much greater than the 600-year period required to render the wastes innocuous. (auth)

**33682** THE TRANSPORT OF RADIOACTIVE MATERIALS. Zaadnoordijk, H. Ziekenhuiswezen, 36: 373(Oct. 1963). (In Dutch)

About 20 radioactive isotopes are now used in medical work, and the problem of disposal of radioactive samples must be considered. A therapeutic dose of $^{131}I$ will be excreted to the extent of 60 to 70%, and the radioactive waste must be disposed. Suggestions for the disposal of gas, liquid, and solid samples are given. Laboratories should have measurement devices to determine activity levels, so that dilutions to allowable concentrations may be made. Areas should be set aside for short-lived isotopes to decay, while those of longer life should be disposed of in protected areas. Excrement of a radioactive nature may be stored in a separate well-ventilated section, where inspection of the area is carried out. Solid materials (glassware, instruments, capsules, linen) are stored in an isolated area until the activity level is so low that they can be handled and cleaned. Extremely active material of long half life should be handled by a central organization. Cadavers and animals may be sealed in plastic bags and maintained in the deep freeze until the level is safe. Burial of solid wastes is suggested and rules for the retraction from use of exposed instruments are mentioned. Gas samples may be treated according to rules of the I.C.R.P.; filters are suggested. (BBB)

**33683** PROCESS FOR TREATING RADIOACTIVE SUBSTANCES. Oetjen, Georg-Wilhelm; Nerge, Wilhelm; Fauser, Friedrich; Eilenberg, Hanns; Neumann, Karlheinz (to Leybold-Anlagen Holding AG). British Patent 994,156. June 2, 1965. Filed Apr. 27, 1962.

A process is described for converting radioactive waste that is in the form of filtrable constituents in a solution into a form fit for handling and storage. The solution is passed through a filtering chamber containing a filtering element that retains the waste. The filtration residue is submitted to a vacuum freeze drying process, and the dry waste is removed for handling and storage. The freeze dried waste may be handled in a variety of ways: smelted or sintered, mixed with a non-radioactive addition material and compacted for fusion or sintering into solid blocks, or removed from the filtering elements by blowing off with a current of gas and/or vapor with subsequent treatment. The filter elements are bags and may be used as carriers or containers themselves since during the filtering process pumping means circulate the solution in such a manner that the solid material is trapped inside the bags during filtration. Heating means operable at a temperature of 50–80°C are provided to accelerate the vacuum freeze drying process. The process is also applicable to the concentration of radioisotopes. (B.L.M.)

# GENERAL AND MISCELLANEOUS

**33684** (BNL-8110) SOME PROBLEMS IN NUMERICAL ANALYTIC CONTINUATION. Cannon, J. R. (Brookhaven National Lab., Upton, N. Y.) Miller, Keith (Rice Univ., Houston, Tex.). [1963]. Contract AT(30-2)-Gen-16. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Three analytic-continuation problems are considered in a general Jordan domain. In each case, an approximating polynomial is determined by a linear programming problem. The existence of such a polynomial is shown. (T.F.H.)

**33685** (BNL-8206) TWENTY-FOUR HOUR DISPERSION OF RAGWEED POLLEN FROM KNOWN SOURCES. Raynor, Gilbert S. (Brookhaven National Lab., Upton, N.Y.); Ogden, Eugene C. (New York State Museum and Science Service, Albany). [196?]. Contract AT(30-2)-Gen-16. 73p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The dispersion of ragweed pollen from known sources has been studied by growing circular plots of plants and surrounding them during the pollination season by arrays of sampling devices. Daily volumetric samples were taken around six sources over a two-year period. Typical patterns of dispersion are described. The change of concentration with distance and its variability are discussed, compared with other published data and related to theory. The relative contributions to air concentration of one nearby source and many distant sources are compared. (auth)

**33686** (CALT-51-3) A COMPARISON OF EARLY DEVELOPMENT AND DIFFERENTIATION IN THE SEA URCHIN EGG WITH ERYTHROPOIESIS AND HEMOGLOBIN SYNTHESIS. Borsook, Henry (California Inst. of Tech., Pasadena. Kerchoff Labs. of Biology). [1965]. Contract AT(04-3)-51. 27p. (CONF-650427-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on Hemoglobin Synthesis, Cambridge, Mass.

The relation of early development and differentiation in the sea urchin egg with protein, nucleic acid, and enzyme synthesis is discussed with emphasis on erythropoiesis and the synthesis of hemoglobin, DNA, and RNA, and the action of the erythropoietin. It is concluded that the underlying biochemistry is similar whether the differentiation entails morphological changes and is one of a series or it is the synthesis of a single, specific protein and is the terminal differentiation of the cell. (94 references.) (C.H.)

**33687** (CALT-221-10) METASTABLE AMORPHOUS FERROMAGNETIC PHASES IN PALLADIUM-BASE ALLOYS. Tsuei, C. C.; Duwez, Pol (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). May 1965. Contract AT(04-3)-221. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Ternary alloys in which the Si content was kept constant at 20 at. % and Co, Fe, and Ni substituted for Pd were rapidly quenched from the liquid state. X-ray and electron diffraction patterns plus transmission electron microscopy studies failed to reveal a structure for the Pd–5 Fe–20 Si, Pd–12 Co–20 Si, and Pd–15 Ni–20 Si alloys. When these alloys were heated at rates >20°C/min, a sudden heat release of ~1 kcal/g-mole occurred at about 420°C. Remanent magnetization and coercive force measurements were performed on some of the alloys. (W.L.G.)

**33688** (COO-1140-107) THE HIGH TEMPERATURE VAPORIZATION AND THERMODYNAMIC PROPERTIES OF TITANIUM MONOSULFIDE. Franzen, Hugo F.; Gilles, Paul W. (Kansas Univ., Lawrence. Dept. of Chemistry). July 27, 1964. Contract AT(11-1)-1140. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The high temperature vaporization of TiS was investigated through the use of total collection Knudsen effusion measurements, mass spectrometric analysis of the vapor, and x-ray diffraction studies of the condensed phases. The vaporization of TiS is congruent and the products are TiS molecules and probably Ti and S atoms. Vapor pressure measurements were made over the temperature range of 1804 to 2186°K; the melting point is approximately 2200°K. The second- and third-law heats of sublimation, $H^{\circ}_{298}$, are 127.8 and 130.0 Kcal/mols respectfully. (W.L.G.)

**33689** (FSU-2690-21) COPPER PROTEINS AND OXYGEN: CORRELATIONS BETWEEN STRUCTURE AND FUNCTION OF THE COPPER OXIDASES. Frieden, Earl; Osaki, Shigemasa; Kobayashi, Hiroshi (Florida State Univ., Tallahassee. Dept. of Chemistry). May 15, 1965. Contract AT-6(1)-2481. 82p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A comprehensive survey of the interaction of the copper proteins and oxygen is presented, including a correlation of structure, function, and other properties of the known copper oxidases and of hemocyanin. The oxygen reactions of hemocyanin, ceruloplasmin, and cytochrome oxidase show half-saturation values far below the other Cu enzymes. The formation of hydrogen peroxide as a reaction product is associated with the presence of one Cu atom per oxidase molecule or catalytic system. Water is the corresponding product of the other Cu oxidases with four or more Cu atoms per molecule, except for monoamine oxidase. Mechanisms for the oxidase action of the two and four electron transfer Cu oxidases and tyrosinase are proposed. These reactions account for the number, the oxidation-reduction potential, and the oxidation state of Cu in the resting enzyme, the cyclical change from Cu(II) to Cu(I), the diatomic nature of $O_2$, the sequence of the oxidation and reduction reactions and other salient features. The catalytic reactions involved in the oxidation of ascorbic acid by plant ascorbate oxidase, ceruloplasmin and Cu(II) are compared. Finally the substrate specificity, inhibitory control, and the detailed mechanism of the oxidase activity of ceruloplasmin are summarized. (auth)

**33690** (NIRS-3) ANNUAL REPORT, 1963. (National Inst. of Radiological Sciences, Chiba (Japan)). Dec. 1964. 93p. Dep.(mn).

Advances are reported in: physical and biological sciences, medicine, and environmental studies. Separate abstracts were prepared for each of the four research areas. (H.G.D.)

*For abstracts of individual sections see: 31670, 31671, 31672, and 32787.*

**33691** (NVO-98-7) LOCAL SAN CLEMENTE ISLAND TEST NO. 2. Interim Progress Report, Task IV. Metzler, Allan R. (National Marine Consultants, Anaheim, Calif.). June 4, 1965. Contract AT(26-1)-98. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The electronics system of the Type I buoy system was given a local shakedown test in water depths of 800 to 1000 ft near San Clemente Island. The instrumentation tested included a polypropylene painter and a telemetry/recording skiff. A temperature sensitivity problem was encountered in the wave measuring sensor data. (D.L.C.)

**33692** (NYO-1397-1) ANNUAL REPORT OF STUDIES ON [METABOLIC RESEARCH]. Sunderman, F. William (Jefferson Medical Coll., Philadelphia, Pa.). May 15, 1965. Contract AT(30-1)-1397. 103p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Metabolic research studies reported include the development of an atomic absorption procedure for the quantitative determination of Ni in urine and other biological materials; a modification of the atomic absorption spectrometric procedure for the determination of Ca and Mg in blood serum; the modification of a colorimetric procedure for use in measurements of vanilmandelic acid in blood samples from a patient with pheochromocytoma throughout the operative period for removal of the tumor; the development of a conductivity method for the estimation of electrolyte concentration in blood serum; the

modification of a cryoscopic method for use in determining the freezing point of biological fluids; and the development of a method for testing the uniformity of concentration of gases in animal exposure chambers. (144 references.) (C.H.)

**33693** (ORNL-3300(Vol.4)) PUBLICATIONS, REPORTS, AND PAPERS FOR 1964 FROM OAK RIDGE NATIONAL LABORATORY. Johnsson, K. O.; Haas, Ann Klein (eds.) (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 297p. Dep.(mn); $3.50(cy), 5(mn) CFSTI.

A bibliography is presented of technical information developed at ORNL and published in 1964. The bibliography is arranged according to the divisions of ORNL. Keyword and author indexes are included. (D.L.C.)

**33694** (PNE-466) MARINE MAMMALS IN THE CHUKCHI SEA. Report of a Survey conducted for the Atomic Energy Commission, March 29-30, 1961. (Bureau of Sport Fisheries and Wildlife, Washington, D. C.). May 25, 1961. 10p. Dep(mn); $1.00(cy), 1(mn) CFSTI.

Results are reported from an aerial survey of walruses in the Bering Sea and marine mammals in the eastern Chukchi Sea, near Cape Thompson, Alaska, in March, 1961. (C.H.)

**33695** (SC-DC-65-1426) A LOGIC FOR MULTIPLE-GENERATION TRACING OF STRUCTURES. Jemison, W. F.; Souther, H. B. (Sandia Corp., Albuquerque, N. Mex.). [May 1965]. Contract AT(29-1)-789. 24p. (CONF-650527-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Association for Computing Machinery, Rio Grande Chapter Meeting, Phoenix, Ariz.

A logic was developed and implemented for efficient tracing of multiple-generation structures where a common ancestor is known. An efficient tape-tracing logic is proposed for determining common ancestors. This logic was evolved in conjunction with the solution of a large-scale product-configuration data problem. The problem setting is discussed, the detailed logic is presented, trace times are discussed, and some proposals are made for minimizing tape processing time. (auth)

**33696** (SC-DR-65-249) MULTIAPPLICATION DC RESISTANCE MODULE (U3487). Branscombe, D. A. (Sandia Corp., Albuquerque, N. Mex.). June 1965. Contract AT(29-1)-789. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A multiapplication module is described for making d-c resistance measurements. (auth)

**33697** (SC-R-65-870) THE THEORY OF CONES. Morrison, D. R. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1965. Contract AT(29-1)-789. 49p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Sandia Corp. Monograph.

The theory of cones in the group-theoretical context is reviewed. The topics studied include cones of functions with slope, subsets of groups, generalized cosets, cones of subsets and convex subsets, classification of cones and cone homomorphisms, cones of automorphisms, and monogenic cones. (T.F.H.)

**33698** (SC-TM-64-995) SUPERIOR ORGANIC COATINGS. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A three-process system (surface preparation, primer, and finish coat) is required to obtain a superior organic coating. The processes must be compatible with each other and must be scheduled so that time intervals are correct. Manufacturing steps between these processes must not adversely affect the completed system. A new nondestructive test method, using steam, can indicate coating quality on the finished part before it leaves the factory. (auth)

**33699** (SC-TM-65-87) SUBSURFACE MARINE DYE MARKER EVALUATION. Voida, George; Page, Cecil (Albuquerque, N. Mex.). May 1965. Contract AT(29-1)-789. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A description is given of the procedures used in processing dye markers and conducting humidity and immersion tests in connection with a study conducted to evaluate subsurface marine dye markers. Also presented is a summary of conclusions reached as a result of the initial evaluation, as well as recommendations for future areas of investigation. (auth)

**33700** (SC-TM-65-93) GAS BEARING ATTITUDE CONTROL SIMULATOR. Schafer, D. R. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A description is given of a spherical gas bearing attitude simulator. The bearing permits 360 degrees of movement in the roll and pitch axes, and 40 degrees of movement in the yaw axis. The apparatus is used to simulate vehicular motion in frictionless environments which permits optical testing of rocket payload control systems in the laboratory. (auth)

**33701** (TID-21897) MECHANISM OF EROSION OF SOLID METALS. Progress Report, April 1965. (Rutgers—The State Univ. of New Jersey, New Brunswick. Bureau of Engineering Research). Contract AT(30-1)-3477. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Solid metal surfaces were subjected to repeated impact by small high-velocity glass spheres in order to determine the various factors and modes of erosion. Examination of the erosion specimens indicated that there were at least two basic modes or phases of erosion and a strong possibility of a third mode. (W.L.G.)

**33702** (TID-21941) MAMMALS OF THE NEVADA TEST SITE. Jorgensen, Clive D.; Hayward, C. Lynn (Brigham Young Univ., Provo, Utah). Mar. 1965. Contract AT(11-1)-1355. 86p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Published in Brigham Young Univ. Sci. Bull., Biol. Ser., 6: No. 3 (Mar. 1965).

Data are presented from a 5-year ecological survey of small mammals of the Nevada Test Site. Data are presented on the behavior and daily activity of individuals as well as populations of each species, seasonal distribution, and distribution among plant communities of 46 species. (60 references.) (C.H.)

**33703** NUCLEAR ENERGY IN GERMANY. Finke, Wolfgang (Federal Ministry for Scientific Research, Godesberg, Ger.). Euratom Bull., 4: No. 2, 34-43(June 1965).

The development of nuclear research and technology in West Germany is reviewed. Germany's nuclear research centers are described and their research programs discussed. Reactor development is reviewed. Costs and financing are considered. (M.C.G.)

**33704** NUCLEONICS HANDBOOK OF REACTOR RESEARCH AND TECHNOLOGY. New York, Nucleonics, [1965]. 255p. $2.00.

General reference data are given on nuclear instrumentation for medicine and biology, measuring gamma activity with whole-body counters, world development of whole-body counters, autofluoroscopes, gamma and positron scintillation camera, solid-state dosimeters for in vivo measurements, miniature p-i-n junctions for in vivo dosimetry, computer techniques, radiotracers in medicine, tailoring the isotope to the need, optimization of a scanning method using $^{99m}$Tc, biological aspects in the choice of scanning agents, high-geometry system for counting low activity levels, developments in nuclear-particle detections, semiconductor and scintillator data analysis, semiconductor detectors, semiconductor properties and applications, isotope costs and availability, isotope-generator reliability and safety, generator performance and mission prospects, RBE for solar-flare protons, separation distance for $^{90}$Sr and $^{244}$Cm, single-stage spaceships, missions for nuclear instruments, surface-barrier detectors for isotopic age measurements, Van de Graaff nuclear structure studies, medical research with high-energy heavy particles, activation analysis, radiation effects on transistors in space, and in-line fission-product monitor. Data are also pre-

sented on power reactors, effects of changing economic conditions on fuel-cycle costs, properties of reactor materials, thermal properties of nuclear materials, radiotracers in analytical chemistry, constants and conversion factors for decay, dose fields from plane sources, neutron-induced activities, neutron spectrometry, gamma shielding design curves, yields from neutron-induced fission, solar-flare proton data, and statistical tests for counting. Data sheets are given on x-ray critical absorption and emission energies in kev, heat transfer across small gas-filled gaps, tenth-value thicknesses for gamma absorption, locating Compton edges and backscatter peaks in scintillation spectra, gamma scattering from thin scatterers, slow-neutron-capture radioisotopes, gamma-detection efficiency of organic phosphors, gamma dose rates in cylindrical sources, gamma attenuation with buildup in lead and iron, radiation from neutron-activated slabs and spheres, radioactivity induced in irradiation attenuation of gammas from infinite plane, relating basic core parameters, absorption of monoenergetic x and gamma rays, neutron activation, criticality of MTR-type fuel elements, neutron-absorption alignment chart, specific activity, beta emitters, parent activity from daughter growth, gamma attenuation coefficients, gamma spectra of short-lived nuclides, and sodium vapor pressure to 25 atm. Data and diagrams are also presented for the Dresden, Elk River, Indian Point, NPD, NS Savannah, and Yankee Reactors. (M.C.G.)

**33705** ARMING DEVICE FOR AERIAL BOMBS. Crumb, Carl B. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,192,858. July 6, 1965.

This invention relates to an arming device for an aerial bomb, comprising a wind operated propeller fixed on a rotatably mounted shaft, a gear train to transmit the propeller torque on said shaft to a screw, said gear train being normally engaged and adapted to be disengaged by longitudinal movement of said shaft, a slider link co-operative with and adapted to move longitudinally with respect to said screw by the rotation of said screw, a toggle linkage having a movable pivot point thereof attached to said slider link, a plunger adapted to be given reciprocal motion by said toggle linkage and a switch mechanism normally urged in an unarmed position activated by said plunger. (AEC)

**33706** HIGH VOLTAGE CABLE. Harris, Clarence A. (to U. S. Atomic Energy Commission). U. S. Patent 3,193,712. July 6, 1965.

A cable for coupling high d-c voltages from a power supply to a load, the cable having an inner conductor and a grounded outer coaxial shield, is described. Intermediate shield conductors are placed in the cable between the inner and outer conductors to reapportion the voltage gradient so that the dielectric is more efficiently utilized, thereby allowing a higher voltage to be applied to the inner conductor. As a further feature, the central conductor and intermediate shields are made of a moderately resistive material to suppress arcs by reducing the effective capacitance of the cable. (AEC)

**33707** SHOCK ABSORBING CASTER WHEEL. Kindley, R. J. (to U. S. Atomic Energy Commission). U. S. Patent 3,194,293. July 13, 1965.

A shock absorbing wheel, wherein a rubber-like tire is disposed between and secured to flanges at a location radially spaced from the hub, is described. Upon application of loads, the tire deforms in shear. A generally T-shaped ring may be embedded in and secured to the tire so that the tire material adjacent the ring stretches in shear throughout circumference of the tire and ring. (AEC)

**33708** METHOD FOR FORMING P-N JUNCTIONS ON SEMICONDUCTORS. Lothrop, Robert P. (to U. S. Atomic Energy Commission). U. S. Patent 3,194,701. July 13, 1965.

A process is described for depositing a layer of phosphorus on the surface of a semiconductor, such as silicon or germanium, to form a P-N junction. The semiconductor, in wafer form, is placed in a furnace adjacent to a container holding an azeotropic mixture of phosphorus pentoxide and water. Inert carrier gas is passed over the azeotrope which transports some of the $P_2O_5$-$H_2O$ to the surface of the semiconductor for deposition. By controlling the temperature, carrier gas flow, and the location of the semiconductor relative to the container, the amount of phosphorus pentoxide deposited is very precisely controlled enabling the formation of a P-N junction of thicknesses down to about 100 Å. (AEC)

**33709** PORTABLE ELECTRIC WELDER. Brons, Charles D.; Rousseau, Louis J.; Gaither, Walter W. (to U. S. Atomic Energy Commission). U. S. Patent 3,194,937. July 13, 1965.

Welding apparatus is described for joining thin-walled tubes by a coupling. The apparatus is formed in pivotally connected halves that swing open to receive the tubes and coupling and swing shut to hold and enclose them in a welding atmosphere. During welding the tubes and coupling are held stationary and a welding electrode rotates about them. The welding electrode is mounted on one of two complementary gear halves that are rotated in order to rotate the electrode. When the halves of the apparatus swing open to receive the tubes and coupling to be welded, the gear halves also swing open. (AEC)

**33710** RADIO FREQUENCY AMPLIFICATION BY STIMULATED EMISSION OF RADIATION. Jeffries, Carson D.; Chamberlain, O.; Schultz, C. H.; Shapiro, G. (to U. S. Atomic Energy Commission). U. S. Patent 3,195,061. July 13, 1965.

A maser type apparatus in which radio frequency signals are amplified with a very low noise level is described. The amplifying crystal is a paramagnetic salt, lanthanum magnesium double nitrate in which approximately 1% of the lanthanum atoms have been replaced by even isotopes of neodymium. The crystal is operated under cryogenic conditions in a magnetic field. A high frequency pump signal applied to the crystal transfers electron spin polarization to proton spin polarization with polarization values exceeding 60%. The normal bandwidth of the amplifier is 50 kc. The frequency is adjusted by varying the intensity of the magnetic field or by changing the direction of the magnetic field through the crystal. (AEC)

**33711** ANALOGUE TO DIGITAL CONVERTER. West, H. I. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,195,123. July 13, 1965.

A time-modulation analogue-to-digital converter is described. In this system a continuous series of equally spaced pulses is passed through an electronic gate. The gate is opened at the instant of the beginning of the linear portion of a voltage ramp which includes both linear and nonlinear portions. The voltage ramp is extended for a time equal to the time of the nonlinear portion. The electronic gate remains open until the linear voltage ramp obtains a predetermined reference level related to the amplitude of the analogue signal to be converted. The number of pulses in the train which pass through the gate is therefore proportional to the analogue voltage. The converter is characterized in that conversion may be accomplished with an extremely high degree of accuracy. (AEC)

**33712** STEPPED GAS BEARING. Anderson, Thure (to U. S. Atomic Energy Commission). U. S. Patent 3,195,963. July 20, 1965.

A gas-lubricated bearing seat for near frictionless static and dynamic support of various shaped objects is described. The bearing seat employs a plurality of horizontally aligned undercut stepped recesses which serve to divert the flow of gas in a manner which provides heretofore unattainable stability with near frictionless support. The bearing seat is especially adapted for use with a gyroscope sphere bearing and also as a precision laboratory instrument for observing the pendulum action and precession of an unbalanced rotating sphere. (AEC)

**33713** NONDESTRUCTIVE EDDY CURRENT SUBSURFACE TESTING DEVICE PROVIDING COMPENSATION FOR VARIATION IN PROBE-TO-SPECIMEN

SPACING AND SURFACE IRREGULARITIES. Libby, Hugo L. (to U. S. Atomic Energy Commission). U. S. Patent 3,197,693. July 27, 1965.

A metal discontinuity measuring device is described. The device comprises a probe having an annular driver coil and a plurality of annular sensing coils mounted coaxially and coplanar with said driver coil and having their outputs connected to give a single resultant output. Means are provided for applying a variable amplitude a-c signal to the driver coil. Means are also provided for varying the amplitude and phase of the outputs of each of the sensing coils such that probe-to-metal motion does not vary the phase of the single resultant output signal, whereby the phase of the single resultant output signal of the sensing coils is a measure of discontinuities within the metal. Means are provided for measuring such phase of the single resultant output signal as an indication of such discontinuities. (AEC)

# CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

| | | |
|---|---|---|
| ä | becomes | ae |
| ö | | oe |
| ø | | oe |
| ü | | ue (except in transliterated Chinese names) |

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# SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

## Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

## Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons ($\pi$), Mesons ($\xi$).

## Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

## Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

## Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

## Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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Proceedings of conferences and conference papers are included in the Report Number Index.

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| 363 | 19-32345 | Dep.(mn) |
| **AERE-M–** | **(British)** | |
| 1371 | 19-32572 | J. Phot. Sci., 12: 312-18(1964) |
| 1563 | 19-33663 | Dep.; $0.70(BIS); 3s. 6d. (HMSO) |
| 1568 | 19-32324 | Dep.; $0.80(BIS), 4s. (HMSO) |
| **AERE-R–** | **(British)** | |
| 4263 | 19-33235 | Dep.; $1.40(BIS), 7s. (HMSO) |
| 4896 | 19-33236 | Dep.; $1.10(BIS), 5s. 6d. (HMSO) |
| 4905 | 19-32278 | Dep.; $1.00(BIS), 5s. (HMSO) |
| **AFAPL-TR–** | **(Non-AEC)** | |
| 65-9 | 19-32775 | |
| **AFBMD–** | **(Non-AEC)** | |
| 61-6 | 19-32543 | See AD-609255 |
| **AFCRL–** | **(Non-AEC)** | |
| 64-690(I) | 19-32501 | See AD-608498 |
| 64-892 | 19-33115 | $1.00(CFSTI) |
| 64-1000 | 19-33401 | See AD-611202 |
| 65-293 | 19-33425 | See SIT-P144 |
| 65-315 | 19-33402 | CFSTI |
| **AFML-TR–** | **(Non-AEC)** | |
| 65-99 | 19-32724 | |
| **AFOSR–** | **(Misc.)** | |
| 5430 | 19-32773 | See AD-611145 |
| 5431 | 19-33513 | See AD-611194 |
| **ANL–** | | |
| 7004 | 19-32117 | Dep.(mn); $5.00(cy), 3(mn) CFSTI |
| 7020 | 19-32046 | Dep.; $6.00(CFSTI) |
| **AP-Note–** | **(Misc.)** | |
| 364 | 19-33589 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 426 | 19-33189 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 444 | 19-33575 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| **APL-TDR–** | **(Misc.)** | |
| 64-124(Vol.I) | 19-33400 | See AD-608379 |
| **ARL–** | **(Non-AEC)** | |
| 64-179 | 19-32502 | See AD-609977 |
| **ASD-TDR–** | **(Non-AEC)** | |
| 63-270(Pt.III) | 19-32717 | See AD-425912 |
| **ATD-P–** | **(Non-AEC)** | |
| 65-1 | 19-32786 | See AD-610054 |
| **BM-RI–** | **(Misc.)** | |
| 6636 | 19-32675 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| **BMI–** | **(Misc.)** | |
| 1717(Del.) | 19-32676 | Dep.; $1.00(cy), 1(mn) CFSTI |
| **BNL–** | | |
| 8110 | 19-33684 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 8187 | 19-32925 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 8206 | 19-33685 | Dep.(mn); $2.00(cy), 2(mn) CFSTI |
| 8541 | 19-31851 | Nature, 206: 950-1(1965) |
| 8714 | 19-31738 | Nature, 206: 949-50(1965) |
| 9086 | 19-33664 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 9119 | 19-32908 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 9137 | 19-33175 | Phys. Rev. Letters, 14: 949-51(1965) |
| 9171 | 19-32119 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 9213 | 19-32828 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 9246 | 19-33048 | Phys. Rev. Letters, 15: 38-41(1965) |
| **BNWL–** | | |
| 27 | 19-32448 | Dep.(mn); $3.00(cy), 1(mn) CFSTI |
| 28 | 19-33590 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| 32 | 19-32726 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 60 | 19-33665 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |

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|---|---|---|
| 61 | 19-33563 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| 67 | 19-32677 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 84 | 19-33220 | See CONF-650504-20 |
| 96 | 19-32776 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| **C–** | **(Misc.)** | |
| 910076-3 | 19-32402 | See N64-18173 |
| **CALT–** | | |
| 51-3 | 19-33686 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 68-36 | 19-32937 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 68-38 | 19-32938 | Dep.(mn); $1.00(cy), 1(mn) CFSTI<br>Phys. Letters, 17: 148-51(1965) |
| 221-10 | 19-33687 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| **CEA-Bib–** | **(French)** | |
| 55 | 19-32926 | Dep.(mn) |
| **CEA-R–** | **(French)** | |
| 2461 | 19-32545 | Dep.(mn) |
| 2614 | 19-33190 | Dep.(mn) |
| 2711 | 19-32546 | Dep.(mn) |
| 2783 | 19-32503 | Dep.(mn) |
| 2795(Vol.II) | 19-33581 | Dep.(mn) |
| **CLM-P–** | **(British)** | |
| 50 | 19-32893 | Nucl. Fusion, 5: 41-6(1965) |
| 51 | 19-33276 | Cryogenics, 5: 132-5(1965) |
| **CNLM–** | **(Misc.)** | |
| 6028 | 19-32694 | CFSTI |
| **CONF-19–** | **(2nd International Congress of Radiation Research, Harrogate, Eng., Aug. 1962)** | |
| 5 | 19-31800 | See UR-663 |
| **CONF-587–** | **(American Nuclear Society 1961 Annual Meeting, Pittsburgh, June 1961)** | |
| 2 | 19-33589 | See AP-Note-364 |
| **CONF-774–** | 19-32260 | **(International Symposium on the Preparation and Biomedical Application of Labeled Molecules, Venice, Aug. 1964)**<br>**See EUR-2200.e** |
| **CONF-621101–** | 19-32825 | **(Conference on Energy Transfer in Gases, Nov. 5–10, 1962)** |
| **CONF-630407–** | 19-32497 | **(Symposium on Dust Control and Air Cleaning, London, Apr. 4, 1963)** |
| **CONF-630503–** | **(Symposium on Punched Taped Techniques in Documentation, Ispra, Italy, May 28–30, 1963)** | |
| 1 | 19-32667 | See EUR-2298.e |
| **CONF-640104–** | **(Cornell Univ. Colloquium, Ithaca, N. Y., Feb. 11, 1964)** | |
| 1 | 19-33567 | See TID-20263 |
| **CONF-640507–** | **(Proceedings of the Second Joint USAEC–Euratom Two-Phase Flow Meeting, Germantown, Md., April 29, 30, and May 1, 1964)** | |
| | 19-32346 | Dep.(mn); $5.50(cy), 9(mn) CFSTI |
| **CONF-640621–** | **(International Symposium on Diffusion of Plasma Across a Magnetic Field, Feldafing/Starnberger See, Germany, June 29–July 3, 1964)** | |
| 1 | 19-33422 | See NYO-2813-30 |
| **CONF-640909–** | 19-32634 | **(International Conference on Radiation Preservation of Foods, Boston, Sept. 27–30, 1964)** |
| **CONF-641105–** | 19-31688 | **(Symposium on the Use of Radioisotopes in Animal Nutrition and Physiology, Prague, Nov. 23–27, 1964)**<br>**See STI-PUB/90** |
| **CONF-650111–** | **(CERN Informal Neutrino Conference, Geneva, Jan., 1965)** | |
| 4 | 19-32908 | See BNL-9119 |
| **CONF-650201–** | **(Proceedings of the ANS Topical Meeting on Nuclear Power Reactor Siting, Los Angeles, February 1965)** | |
| | 19-32449 | Dep.; CFSTI |
| **CONF-650413** | **(Symposium on Neutron Dynamics and Control, Tucson, Ariz., Apr. 5–7, 1965)** | |
| 4 | 19-33564 | See GA-6283 |
| **CONF-650427–** | **(Symposium on Hemoglobin Synthesis, Cambridge, Mass., Apr. 8–9, 1965)** | |
| 1 | 19-33686 | See CALT-51-3 |
| **CONF-650501–** | **(The Application of Computing Methods to Reactor Problems, Argonne, Ill., May 17–19, 1965)** | |
| 10 | 19-33566 | See ORNL-P-1235 |
| 11 | 19-33569 | See WAPD-T-1762 |
| **CONF-650504–** | **(IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Germany, May 10–14, 1965)** | |
| 15 | 19-33671 | ORINS |
| 16 | 19-33225 | ORINS |
| 17 | 19-33219 | ORINS |
| 18 | 19-33221 | ORINS |
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| 30 | 19-33222 | ORINS |
| 31 | 19-33574 | ORINS |
| 32 | 19-33232 | ORINS |
| 33 | 19-33231 | ORINS |
| 34 | 19-33218 | ORINS |
| 35 | 19-33230 | ORINS |
| 36 | 19-33672 | ORINS |
| 37 | 19-33645 | ORINS |
| **CONF-650507–** | **(IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna, May 24–28, 1965)** | |
| 4 | 19-32597 | ORINS |
| 5 | 19-32107 | ORINS |
| 6 | 19-32106 | ORINS |
| 7 | 19-31778 | ORINS |
| 8 | 19-32595 | ORINS |
| 9 | 19-32105 | ORINS |
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| 20 | 19-32108 | ORINS |
| 21 | 19-32109 | ORINS |
| 22 | 19-32100 | ORINS |
| 23 | 19-31782 | ORINS |
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| 27 | 19-32596 | ORINS |
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| 29 | 19-32102 | ORINS |
| 30 | 19-32097 | ORINS |
| 31 | 19-31780 | ORINS |
| 32 | 19-32276 | ORINS |
| 33 | 19-32594 | ORINS |
| 34 | 19-32598 | ORINS |
| **CONF-650518–** | **(Royal Society Discussion on Deformation of Solids Due to Liquid Impact, London, May 27, 1965)** | |
| 1 | 19-32695 | |

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|---|---|---|
| **CONF-650520–** | **(IAEA Symposium on Exchange Reactions, Upton, New York, May 31–June 4, 1965)** | |
| 2 | 19-32119 | See BNL-9171 |
| **CONF-650523–** | **(Symposium on Radiation and Terrestrial Ecosystems, Richland, Wash., May 3–5, 1965)** | |
| 1 | 19-32420 | See ORNL-P-1239 |
| **CONF-650524–** | **(European Nuclear Energy Agency and Atomic Energy Commission Seminar, Upton, N. Y., May 3–7, 1965)** | |
| 1 | 19-33238 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| **CONF-650527–** | **(Association for Computing Machinery, Rio Grande Chapter Meeting, Phoenix, Ariz., May 13–14, 1965)** | |
| 2 | 19-33695 | See SC-DC-65-1426 |
| **CONF-650606–** | **(EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels, June 10–11, 1965)** | |
| 6 | 19-33602 | See GA-6146 |
| **CONF-650707–** | **(IEEE Annual Conference on Nuclear and Space Radiation Effects, Ann Arbor, Mich., July 12–15, 1965)** | |
| 1 | 19-32778 | See SC-DC-65-1421 |
| **COO–** | | |
| 427-40 | 19-32802 | J. Math. Phys. (N. Y.), 6: 1009-14(1965) |
| 578-P27-7 | 19-32727 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 587-2 | 19-31701 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 587-17 | 19-33514 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 1140-107 | 19-33688 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 1420-111 | 19-33322 | Phys. Rev., 139: B1-8(1965) |
| **CRDC–** | **(Canadian)** | |
| 1216 | 19-32056 | Dep.; $0.50(AECL) |
| **DASA–** | **(Misc.)** | |
| 1573 | 19-32885 | See AD-610869 |
| **DP–** | | |
| 965 | 19-33601 | Dep.; $2.00(cy), 1(mn) CFSTI |
| **DRI–** | **(Misc.)** | |
| 1092-210 | 19-32728 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 1092-211 | 19-32729 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 1092-212 | 19-32730 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| **DS–** | **(Non-AEC)** | |
| 141 | 19-32718 | See AD-608398 |
| **DUBNA REPORTS** | **(Russian)** | |
| See JINR (Russian) | | |
| **ECOM–** | **(Non-AEC)** | |
| 2462(Pt.I) | 19-32614 | See AD-609932 |
| **EUR–** | **(European Atomic Energy Community)** | |
| 2092 | 19-32703 | See EURAEC-1297 |
| 2200.e | 19-32260 | European Atomic Energy Community |
| 2240.f | 19-32057 | Dep.(mn) |
| 2243.f | 19-33666 | Dep.(mn) |
| 2274.e | 19-32547 | Dep.(mn) |
| 2294.e | 19-33191 | Dep.(mn) |
| 2298.e | 19-32667 | Dep.(mn) |
| 2317 | 19-32394 | See EURAEC-1341 |
| 2324 | 19-32731 | See EURAEC-1349 |
| 2402.f | 19-32624 | Dep.(mn) |
| 2409.d | 19-32382 | Dep.(mn) |
| 2415.e | 19-31784 | Dep.(mn) |
| 2432.d | 19-32383 | Dep.(mn) |
| 2436.e | 19-31697 | Dep.(mn) |
| **EURAEC–** | | |
| 783 | 19-32696 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 1297 | 19-32703 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 1341 | 19-32394 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 1349 | 19-32731 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 1376 | 19-32344 | See ACNP-65001 |
| 1395 | 19-32727 | See COO-578-P27-7 |
| **FDL-TDR–** | **(Non-AEC)** | |
| 64-113 | 19-32702 | See AD-609653 |
| **FSU–** | | |
| 2690-21 | 19-33689 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| **FTD-TT–** | **(Non-AEC)** | |
| 64-1352 | 19-32471 | CFSTI |
| 65-27 | 19-32788 | CFSTI |
| **GA–** | **(Misc.)** | |
| 4828 | 19-33194 | See N64-18279 |
| 5615 | 19-32885 | See AD-610869 |
| 5978 | 19-32058 | Dep.; $3.00(cy), 2(mn) CFSTI |
| 6096 | 19-33192 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| 6146 | 19-33602 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 6283 | 19-33564 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| **GA-ME–** | **(Non-AEC)** | |
| 64-5 | 19-32922 | See AD-610176 |
| **GEAP–** | **(Misc.)** | |
| 4745 | 19-32732 | Dep.; $3.00(cy), 2(mn) CFSTI |
| 4816 | 19-33603 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| **GEMP–** | **(Misc.)** | |
| 48A | 19-32678 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| **HAVENS–** | | |
| 191 | 19-32705 | See TID-21918 |
| **HPR–** | **(Norwegian)** | |
| 57 | 19-33604 | Dep.(mn) |
| **HW–** | | |
| 83480 | 19-32548 | Dep.; $3.00(cy), 2(mn) CFSTI |
| **HW-SA–** | | |
| 3548 | 19-32281 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 3556 | 19-31698 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 3588 | 19-33239 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 3637 | 19-33654 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 3667 | 19-31854 | Nature, 206: 945-6(1965) |
| 3679 | 19-31898 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 3694 | 19-31716 | Am. J. Physiol., 209: 158-64(1965) |
| **IC–** | **(Misc.)** | |
| 65/29 | 19-33028 | Phys. Rev. Letters, 14: 968-72(1965) |
| 65/55 | 19-32939 | Dep.(mn) |
| 65/56 | 19-32940 | Dep.(mn) |
| **IDO–** | | |
| 12042 | 19-32467 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 14608 | 19-33675 | Dep.(mn); $4.00(cy), 3(mn) CFSTI |
| 14655 | 19-32059 | Dep.; $6.00(cy), 4(mn) CFSTI |
| 17037 | 19-32679 | Dep.; $3.00(cy), 1(mn) CFSTI |
| 17052 | 19-32680 | Dep.; $3.00(cy), 2(mn) CFSTI |
| **IFA-CRD–** | **(Romanian)** | |
| 30 | 19-33240 | Dep.(mn) |
| **IITRI–** | **(Misc.)** | |
| 1184-17 | 19-33514 | See COO-587-17 |
| B237-34 | 19-32704 | |
| B6019-1 | 19-32692 | See AD-426040 |
| B6021-5 | 19-32719 | See AD-609727 |
| B6035-7 | 19-32727 | See COO-578-P27-7 |
| **INR–** | **(Polish)** | |
| 461/I | 19-33241 | Dep. |
| **INSJ–** | **(Japanese)** | |
| 85 | 19-32549 | Dep.(mn) |
| **IPP–** | **(Non-AEC)** | |
| 6/35 | 19-33403 | Dep.(mn) |
| **IS–** | | |
| 1044 | 19-32418 | Geochim. Cosmochim. Acta, 29: 633-41 |

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|---|---|---|
| 1121 | 19-32120 | Dep.(mn); $4.00(cy), 2(mn) CFSTI |
| IS-T- | | |
| 10 | 19-33515 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| ISS- | (Italian) | |
| 64/45 | 19-33242 | Dep.(mn) |
| JAERI- | (Japanese) | |
| 4032 | 19-33243 | Dep.(mn) |
| JINR- | (Russian) | |
| E-2156 | 19-32941 | Dep.(mn) |
| P-2065 | 19-32942 | Dep.(mn) |
| P-2067 | 19-32943 | Dep.(mn) |
| P-2073 | 19-32944 | Dep.(mn) |
| P-2079 | 19-33244 | Dep.(mn) |
| P-2083 | 19-32945 | Dep.(mn) |
| P-2086 | 19-33245 | Dep.(mn) |
| P-2089 | 19-32946 | Dep.(mn) |
| P-2090 | 19-32947 | Dep.(mn) |
| P-2106 | 19-33085 | Dep.(mn) |
| P-2107 | 19-32948 | Dep.(mn) |
| P-2132 | 19-32668 | Dep.(mn) |
| JPRS- | (Non-AEC) | |
| 29696 | 19-32707 | $6.00(CFSTI) |
| K- | | |
| 1635 | 19-32187 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| KAPL-M- | | |
| 6453 | 19-32384 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 6455 | 19-33246 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 6459 | 19-32385 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| 6464 | 19-33529 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| KFK- | (German) | |
| 287 | 19-32047 | Dep.(mn) |
| 314 | 19-32658 | Dep.(mn) |
| KLX- | (Misc.) | |
| 1869 | 19-32625 | Dep.; $3.00(cy), 2(mn) CFSTI |
| LA- | | |
| 3320 | 19-33404 | Dep.; $4.00(cy), 2(mn) CFSTI |
| LA-DC- | | |
| 6963 | 19-32147 | J. Chem. Phys., 43: 944-7(1965) |
| 7062 | 19-33656 | Astronaut. Aeronaut., 3: No. 6, 42-6(1965) |
| 7064 | 19-33340 | Phys. Rev. Letters, 14: 962-5(1965) |
| 7102 | 19-33334 | Phys. Rev. Letters, 14: 913-15(1965) |
| LADC- | | |
| 6480 | 19-32949 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| LAMS- | | |
| 3015 | 19-32886 | Dep.(mn); $6.00(cy), 4(mn) CFSTI |
| LF- | | |
| 22 | 19-32060 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| MAB- | (Non-AEC) | |
| 199-M(3) | 19-32681 | |
| MATT- | | |
| 277 | 19-33466 | Nucl. Fusion, 5: 68-72(1965) |
| 324 | 19-32121 | Dep.; $4.00(cy), 3(mn) CFSTI |
| MIT- | (Misc.) | |
| 334-11 | 19-32208 | Dep.; $4.00(cy), 2(mn) CFSTI |
| 2098-104 | 19-33331 | Phys. Rev., 139: B80-91(1965) |
| 2098-127 | 19-32970 | J. Math. Phys. (N. Y.), 6: 941-54(1965) |
| 2098-137 | 19-33022 | Phys. Rev. Letters, 14: 921-3(1965) |
| MITNE- | (Misc.) | |
| 55 | 19-32208 | See MIT-334-11 |
| MLM- | | |
| 1247 | 19-32061 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| MND- | (Misc.) | |
| 2706-14 | 19-33605 | Dep.(mn); $7.51(cy), 7(mn) CFSTI |
| 3176 | 19-32921 | See AD-610151 |
| 3297-9 | 19-33606 | Dep.(mn); $6.00(cy), 5(mn) CFSTI |
| MND-C- | | |
| 2933 | 19-33193 | |
| MND-P- | | |
| 3005 | 19-32655 | Dep.(mn); $3.00(cy), 2(mn) CFSTI |
| 3006 | 19-32656 | Dep.(mn); $4.00(cy), 2(mn) CFSTI |
| 3007 | 19-32657 | Dep.(mn); $5.00(cy), 3(mn) CFSTI |
| MPI-PA- | (Misc.) | |
| 16/64 | 19-33421 | Dep.(mn) |
| MSAR- | (Misc.) | |
| 65-89 | 19-32682 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| MTI- | (Misc.) | |
| 64TR72(Rev.2) | 19-32333 | See NYO-3363-1 |
| N- | (Misc.) | |
| 64-18173 | 19-32402 | $3.60(CFSTI) |
| 64-18279 | 19-33194 | $4.60(CFSTI) |
| 64-18291 | 19-32550 | $1.10(CFSTI) |
| 64-18475 | 19-33116 | $3.60(CFSTI) |
| 64-23197 | 19-32403 | $9.60(CFSTI) |
| NAA-SR- | | |
| 10738 | 19-32282 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| 10856 | 19-32615 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 11047 | 19-32733 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| NAA-SR-Memo- | | |
| 9202 | 19-33195 | Dep.(mn); $1.00(cy), 1(mn) CFSTI |
| 11135 | 19-33607 | Dep.(mn); $2.00(cy), 1(mn) CFSTI |
| NAS-NS- | (Misc.) | |
| 3008(Rev.) | 19-32249 | Dep.(mn); $1.00(cy), 2(mn) CFSTI |
| NASA-CR- | (Misc.) | |
| 53389 | 19-32550 | See N64-18291 |
| 53472 | 19-32402 | See N64-18173 |
| 53611 | 19-33116 | See N64-18475 |
| 54001 | 19-33194 | See N64-18279 |
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